ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 63. No. 23. 220 Broadway, New York, June 9, 1910.

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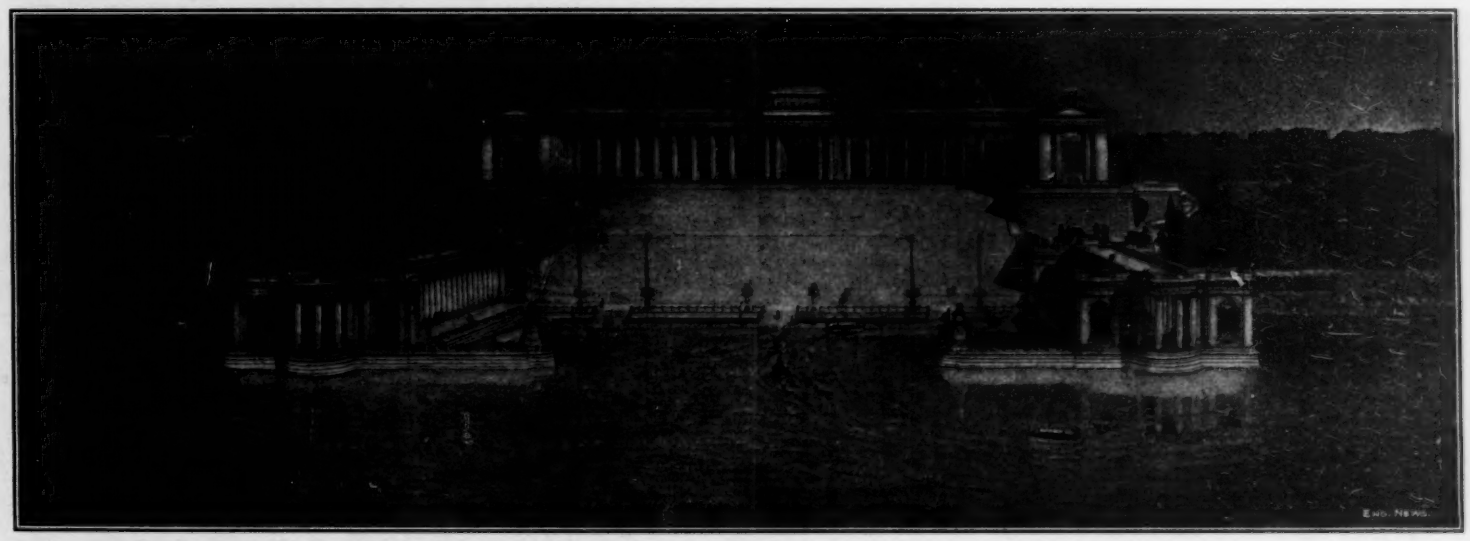
Prize Design for the Fulton Memorial Gateway, New York City.

In the final competition of designs for a memorial water gate, which the Robert Fulton Memorial Association seeks to have erected on the Hudson River at Riverside Drive, New York City, the first prize has been awarded to Mr. H. Van Buren Magonigle, of New York City. This design is shown in the accompanying figure. The gateway is 564 ft. long, extending, as planned, from 114th to 116th St. At the top of the bank is an open peristyle in the center of which is shown the tomb of Robert Fulton. A building at the left end of the peristyle is for the reception of guests of the city or country and a similar building at the right is designated as a naval museum. From the peristyle, a flight of 165 broad steps descends 90 ft., to the water. Two piers, bearing colonnades, project out into the river 340 ft., and form a pool 250 × 350 ft. Small boats may be moored at the piers inside the pool, while large craft will be forced to tie up on the outside or to anchor in midstream. The distance from the pierheads to the rear of the peristyle is some 700 ft. The flat roofs of the colonnades are laid out as promenades and recreation areas.

Nothing is seen in the design to commemorate the names and works of early steamboat builders other than Robert Fulton.

The structure is designed to be built largely of steel and reinforced concrete; some parts are designed as a steel skeleton faced with masonry. The estimated cost is given by Mr. Magonigle as $2,500,000, but this neglects many details which, if included in a close estimate, would increase that sum to $3,000,000 perhaps.

The greater part of the money necessary for the construction must be raised by popular subscriptions from the country at large. It is expected that the Robert Fulton Memorial Association will undertake to raise the needed funds.



DESIGN OF A MEMORIAL GATEWAY FOR RIVERSIDE DRIVE, NEW YORK CITY.

(Mr. H. Van Buren Magonigle, Architect; Design awarded first prize in a competition instituted by the Robert Fulton Memorial Association.)

A Treaty for the Control of International Waterways.

In Engineering News, Jan. 21, 1909, was noted the signing of a treaty, popularly known as the "Waterways Treaty," between the United States and Great Britain for fixing the international boundary between this country and Canada, for determining the amounts of water that could be diverted from international waterways and for the disposition of all differences arising at the boundary or in adjacent territory by a joint high commission which should supersede the old International Waterways Commission.

At that time the injunctions of secrecy had not been removed by the Senate and exact or official information about the provisions of the treaty were not obtainable. The formalities connected with this treaty have now all been completed and the document has been made public. The provisions of most interest to engineers are stated in what follows.

The treaty first provides that the navigation of international waterways shall continue free and open to both countries alike and without discrimination. The same rights of navigation extend to the waters of Lake Michigan and of all canals, connecting boundary waters, now existing or hereafter constructed. The rules, regulations and tolls for the use of such canals are to apply alike to parties from both countries.

The second article of the treaty reserves to each country, or to state and provincial governments, control over the diversion of water on its own side of the boundary, but it is agreed that injury resulting on the one side as the result of interference or diversion on the other side shall give rise to the same rights and shall entitle injured parties to the same remedies as though the interference occurred on the same side as the resultant injury. However, no rights are surrendered by either country, through the treaty, to object to any diversion or interference that injures the interests of navigation.

It is specifically agreed that it is expedient to maintain the present level of Lake Erie and, to that end, to limit the diversion of water from the Niagara River. Diversion of water from this river within New York State for power purposes is limited to 20,000 cu. ft. per sec. daily. The limit of similar diversion within the Province of Ontario above Niagara Falls is 36,000 cu. ft. per sec. daily. According to the experience of the power companies at Niagara Falls these diversions of water would yield 200,000 HP. on the American side and 360,000 HP. on the Canadian. (See Report of the International Waterways Commission, Engineering News, Jan. 21, 1909.)

Contrary to early reports concerning the treaty, no definite limitation is placed on the amount of water which may be drawn by the Chicago Drainage Canal. It is briefly stated that the prohibitions mentioned shall not apply to the

diversion of water for sanitary or domestic purposes or for navigation canals.

An International Joint High Commission is established, composed of six commissioners. Three of these are to be appointed by the President of the United States and three by the King on recommendation of the Governor and Council of the Dominion of Canada. This Commission will pass on all cases involving the use, diversion or obstruction of the boundary waters, but the Commission is required to follow an order of precedence among the uses of such waters. No use is to be permitted which tends to conflict materially with another use which is given preference by the following order: (1) for domestic and sanitary purposes, (2) for navigation and for canals for navigation, (3) for power and irrigation works.

A majority of this Commission is given power to render a decision. In case the Commission is evenly divided separate reports are to be made to the two governments for adjustment of the question. If an agreement is then reached, it is to be transmitted to the Commissioners to take proceedings to carry it out.

The American and Canadian sections may each have a secretary, and the Commission may employ such engineers and clerical assistants as it may deem advisable. The Commission is given power to take evidence on oath, to compel the attendance of witnesses and to adopt rules of procedure.

The scope of the Commission's activities is greatly broadened by articles of the treaty which provide (1) that questions or matters of difference, not related to international waterways but involving the rights, interests and obligations of either country along the common frontier, shall be referred to the commission for examination and report and (2) that any matters of difference involving the United States or Canada may be referred to the Joint Commission for decision. The first of these broader powers does not permit the Commission's reports to be held as decisions or arbitral awards. In exercising the second of the broad powers noted the findings of the commission are decisions; in event of an even division, the commissioners are to report to their respective governments and the questions involved are to be submitted to an umpire selected in accordance with the provisions of The Hague Convention of 1907, for the settlement of international disputes.

The Metropolitan Sewerage Commission Against the Discharge of Treated Passaic Valley Sewage into New York Bay.*

In a report submitted by this Commission to your Honor on March 1, 1910 [see Eng. News, March 10, 1910—Ed.], reference was made to a number of proposed trunk sewers which will add materially to the pollution of the harbor by carrying the sewage of inland cities to the immediate vicinity of New York City for disposal. One of these sewers is that of the Passaic Valley Sewerage Commissioners, of New Jersey. To prevent the execution of the Passaic Valley project a suit is pending in the U. S. Supreme Court between the People of the State of New York, complainants, and the State of New Jersey and Passaic Valley Sewerage Commission as defendants.

The U. S. Government by permission of the Court became a co-plaintiff in this suit, but has recently entered into an agreement with the defendants [see Eng. News, May 12, 1910—Ed.] whereby the objections of the Government have been removed. It is expected that this agreement will be followed by the withdrawal of the State of New York, thus permitting the construction of the Passaic Valley sewer and the discharge of its sewage, after partial purification, into Upper New York Bay.

The Metropolitan Sewerage Commission has given close attention to the Passaic Valley project since 1906. The question was also studied by the New York Bay Pollution Commission [predecessor of the Metropolitan Commission—Ed.] from 1903 to 1906. The Pollution Commission objected to it in general and specific terms, and recommended that the State of New York bring the action which is now pending in the Supreme Court of the United States to prevent the execution of the proposed works. The plans for the works have been altered somewhat since this suit was begun, but they have not been wholly relieved of their objectionable features. The Metropolitan Sewerage Commission respectfully advises your Honor that the project as now announced should be opposed by the City and State of New York as involving serious danger of nuisance and injury to the public health.

Upon its face the present plan of the Passaic Valley Commissioners appears to be a decided improvement upon the project formerly announced, but it is the opinion of the Metropolitan Sewerage Commission that the method of disposal is still objectionable. The degree of purification is insufficient. There are features connected with the outlets which are untried, experimental and of uncertain practicability. The agreement provides for the enforcement of the contract by the U. S. War Department instead of by the City or State of New York or an Interstate Commission, where jurisdiction over the sanitary condition of the harbor properly belongs.

Plan of the Passaic Valley Commissioners.

The proposition of the Passaic Valley Sewerage Commissioners is to collect the house drainage of Newark, Paterson, and about 30 other municipalities or townships in the Passaic Valley and discharge it into Upper New York Bay. This would be done by an extensive system of sewers and a tunnel running under Newark Bay, Bayonne and New York Bay to the neighborhood of Robbin's Reef. The tunnel would discharge the sewage through a number of outlets at the bottom of the harbor near the edge of the main ship channel. The sewage would be screened and passed through settling basins in order to remove solid particles and grit. The number of persons tributary to the sewer would be about 600,000 when the works were first put into operation. The quantity of sewage would increase with the population up to the full capacity of the sewer, when there would be about 1,650,000 people contributing their sewage to the works.

Insufficient Purification.

The purification intended would not be sufficient to admit of the discharge of the Passaic Valley sewage at Robbin's Reef. The process contemplated is designed solely to remove solid matters, and has no reference to the dissolved organic matters which may be present and from which a large part of the total nuisance may be anticipated. There will be little solid matter to be removed from the sewage. Owing to mechanical and biological actions in the sewer much of the solid matter will be broken up into extremely fine particles which will escape the screens and settling basins and pass into the harbor water.

Even the removal of a very large percentage of the suspended matter in the sewage would not purify the sewage to a satisfactory extent. Most of the organic matter in all sewage is present in dissolved form. Because of its long passage through the sewers the sewage will, in all probability, be in a septic, or rotten, condition and consequently very offensive.

Owing to its septic condition the sewage will have a great avidity for the oxygen dissolved in the harbor water, and the investigations of this Commission indicate that the supply of oxygen in the harbor is already deficient because of the sewage which is being discharged.

The discharge of so large a quantity of sewage into the harbor in one locality, even though the outlets be scattered over an area of several acres, would almost certainly result in the reduction of the dissolved oxygen at times of imperfect dispersion, and, during times when the currents would be stationary or recently reversed, to so low a point as to invite putrefaction and the consequent evolution of foul odors from the water and sewage mixture. In this connection it should be remembered that the point of outfall would be in the land-locked part of the harbor, within sight of the most densely crowded business section of New York City within a distance of one mile of the Borough of Richmond and three miles of the Borough of Brooklyn.

Unusual Rights Apparently Granted by the United States Government.

The agreement entered into by the U. S. Government and the Passaic Valley Sewerage Commissioners contains the provision that the discharge of the sewage into the harbor at the locality chosen shall not reduce the available supply of dissolved oxygen in the water below the limit that would injuriously affect major fish life in the water thereabouts. This provision apparently grants to the Passaic Valley Sewerage Commission the right to absorb all the margin of sewage capacity now remaining in the harbor waters, and opens the way to complications of a serious nature. The U. S. Government should not, and perhaps cannot, legally grant to the Passaic Valley Sewerage Commissioners the total or any definite proportion of the remaining capacity of the harbor waters to receive sewage.

Experimental Method of Discharge.

The method proposed for the discharge of the sewage beneath the surface of the harbor involves many constructional difficulties and uncertainties. It is not known that outlets of the form and character proposed can be constructed and maintained at the place designated. If, after the work on the tunnel shall have been partly or wholly completed, it be found that the system of outlets proposed cannot be built for the amount of money available, it is within the range of possibility that the plans now agreed upon would be changed to a simpler and less expensive form of construction to the material disadvantage of the method of disposal.

Extensive studies, including thousands of analyses, made by the Metropolitan Sewerage Commission concerning the quality of the water in Upper New York Bay, indicate that the discharge of sewage in the manner and in the quantities proposed by the Passaic Valley Commission would be attended by a heavy draft upon the capacity of the harbor for assimilating sewage. The quality of the water at the present time shows unmistakably the effects of the sewage now discharged into the harbor. The welfare of the cities situated upon the shores of the harbor requires that the water shall not be unnecessarily contaminated with the sewage of inland communities. The burden of pollution should be increased only when strictly necessary, as where cities are situated on the water front and can provide no other method of disposal.

It is reasonably certain that a nuisance would appear at the outfall. The sewage from the Passaic Valley district cannot reasonably be expected to disappear without the production of local nuisance, including discoloration of the water, the appearance of greasy scum and offensive odors.

Availability of Other Methods of Disposal.

It is not the duty of the Metropolitan Sewerage Commission of New York to solve the problems confronting the Passaic Valley Sewerage Commissioners and state in detail what solution of this question should be adopted, but the plan proposed by the Passaic Valley Commission is not the only one available for disposing of the sewage.

It would be better, in the judgment of the Metropolitan Sewerage Commission, for the sewage of the Passaic Valley district to be purified upon the Newark meadows and the effluent discharged into Newark Bay. There is a large movement of tidal water in Newark Bay, and the saving in cost which would be effected if it were not necessary to construct an outfall tunnel beneath Newark Bay, the Bayonne Peninsula and New York Bay, with the expensive system of outlets proposed, would go far toward paying the cost of purifying the sewage to an extent which would make the discharge of the effluent into Newark Bay a safe procedure.

The suggestion that the Passaic Valley sewage be purified on the Newark meadows and discharged into Newark Bay should not be interpreted as an expression of opinion by the Metropolitan Sewerage Commission favorable to the Passaic Valley enterprise in any of its aspects. The collection of the sewage of that large territory to a central point for disposal is not the only way in which the sewage problems of the Passaic Valley can be solved. It might be more desirable to collect and dispose of the sewage of the different municipalities concerned on some other basis, as, for example, by a number of sewerage districts and at a number of sewage disposal plants. Favorable reports upon such projects have been made by eminent engineers at the instance of the City of Paterson in the Passaic Valley district.

The Secretary of War as Referee.

The agreement entered into between the U. S. Government and the Passaic Valley Commission stipulates that the sewage would produce no effects objectionable to the Secretary of War of the United States, either through interference with the navigable character of the channels or through the production of nuisance or conditions injurious to the public health. The agreement mentioned does not give adequate assurance to the people of New York City and State that the Passaic Valley project will not become a public nuisance, and the method of enforcing the agreement is open to criticism.

The agreement is between the Passaic Valley Sewerage Commissioners and the United States through the Secretary of War. The War Department is not a legal health authority and has no responsibility of a sanitary nature toward the State of New York or New York City. If the Passaic Valley sewage became a serious nuisance or menace to health to the people of New York City or State, it could not properly be objected to by the Secretary unless injury were done to the property of the U. S. Government. This property, including, principally, fortifications, is of insignificant character as compared with the interests of the City and State of New York.

Were the Passaic Valley sewage to produce a nuisance or substantial injury to the health of the cities situated upon the harbor of New York, there would be no way to stop the nuisance except by long and tedious litigation and the construction of extensive public works. Once the Passaic Valley sewer was built and in operation it

*Being a "Report on the Discharge of Sewage from the Proposed Passaic Valley Sewer of New Jersey," by the Metropolitan Sewerage Commission of New York; dated May 23, 1910, and addressed to Hon. W. J. Gaynor, Mayor of the City of New York. The members of the commission are: George A. Soper, President; James H. Fuertes, Secretary; H. de B. Parsons, Charles Sooysmith, Dr. Linsly R. Williams; except Dr. Williams, all Members of the American Society of Civil Engineers. The offices of the Commission are at 17 Battery Place, New York City.

would be impracticable to put a stop to the discharge of sewage through it, for the cities tributary to it would then have no other outlet for their offensive and dangerous wastes.

Action Recommended.

The present status of the Passaic Valley case is as follows: The State of New York brought suit against the Passaic Valley Sewerage Commission and State of New Jersey in the U. S. Supreme Court to prevent the execution of the Passaic Valley project. The U. S. Government requested and obtained permission to intervene in this suit and become a co-plaintiff in order to protect United States property in New York harbor against injurious consequences from the sewage. An agreement was thereafter entered into between the United States and the defendants whereby the latter agreed to purify the sewage to an extent and in a manner specified, on condition that the United States would withdraw from participation in the suit. This agreement has been ratified by the New Jersey Legislature and by the U. S. Attorney General. The suit still continues as between the State of New York and the defendants, but it is expected to be withdrawn unless continued for some unexpected reason.

The Metropolitan Sewerage Commission of New York recommends to your Honor that the City of New York take steps to assert its legal rights in the premises, and it is suggested that application be made to the U. S. Supreme Court for permission to intervene in the suit in order to become a co-plaintiff, to the end that public health and welfare in the City of New York shall be adequately protected.

A large amount of technical information bearing upon the capacity of New York harbor to assimilate and otherwise dispose of the sewage of the Passaic Valley, and data concerning the probability of a nuisance from this source, are contained in the report of the Metropolitan Sewerage Commission dated April 30, 1910 [not yet published—Ed.].

The New York State Barge Canal.

On Nov. 5, 1903, the voters of the State of New York, by a majority of 245,323 out of a total of 1,100,703 votes cast, decided in favor of a bond issue of $101,000,000 to be expended in the construction of a barge canal approximately on the line of the old Erie Canal from Lake Erie at Buffalo to Waterford on the Hudson River, on the line of the old Oswego Canal from Syracuse to Lake Ontario at Oswego and of the old Champlain Canal from Waterford north to Lake Champlain at Whitehall.

In the words of the act of the Legislature authorizing a vote on this bond issue the new canal "should not be less that 12 ft. deep throughout with a bottom width of not less than 75 ft. with such side slopes or vertical walls of masonry or rock as might be necessary to give a cross sectional area of the canal prism of at least 1,125 sq. ft." in the ordinary sections. The old Erie Canal in 1903, increased in size several times since its opening in 1825, had a depth varying from 6 to 9 ft. with a variable bottom section and the other two connecting canals were somewhat smaller, so that the new barge canal was to have a marked increase in carrying capacity. Whereas the old canal carried boats of a capacity of about 250 tons, the Barge Canal was originally designed for 1,000-ton barges and, as will be shown later, is being built for barges of even greater capacity, probably 2,000 tons.

As most of our readers know, Engineering News consistently opposed the appropriation of funds for the construction of a canal which would require transshipment at New York and at Buffalo. The reasons for this opposition have been fully set down in our pages in the past and do not need to be restated here. In the seven years that have elapsed since the campaign was waged we have seen no reason to change our views on the economic desirability of the Barge Canal. On the other hand, its construction is one of the largest individual pieces of engineering work now going on in this country and so is worthy of description. Actual construction has now been in progress for the best part of four years and has reached a point where there is hardly any possibility of marked change in plans, so that a description of the general design of the canal, and of the structures upon it, together with a brief account of the progress of the work as observed in a 10-day trip over the line by a member of the staff of Engineering News should prove of interest to the reader.

In the early days when the old system of canals were dug across the state of New York there was but one method of towing, the teams of horses that even to-day pull most of the boats on the more modernized canals. This required a tow-path and consequently forbade the canalization of any river unless that river were small enough or its natural channel near enough shore to permit of the ordinary driveway for the horses or mules. As a result, in the whole line of the old canal system from Buffalo across to the Hudson, from Syracuse up to Lake Ontario and from Waterford up to Lake Champlain, the only sections of canalized river is a short length of Tonawanda Creek and some occasional stretches of the Seneca River on the line of the Oswego Canal. To-day, however, mechanical haulage of one kind or another, mainly steam or gasoline towboats, is gradually supplanting the mule, so that in the design of the new canal only mechanical towing is considered and no tow-paths have to be provided.

Again, a century ago when the first canals were built the control of such rivers as the Mohawk and the Seneca was beyond the ability of the engineer so that even in those places where a tow-path was possible, the question of storage of flood-protection prevented any but the simplest river channels to be used.

Aside from the mere question of increased size the main difference between the Erie Canal of 1825 and the Barge Canal of 1910 is this one of river utilization. Across the state and up to the northern lakes the modern canal follows very closely the route of its predecessor, except that in the former about 55% of the line is in the channel of the rivers or lakes adjacent. Near the large cities the route is changed in nearly every case so as to take the Barge Canal outside of the city proper and avoid the heretofore disagreeably obstructive lift bridges, but except for this and for some few straightening of curves, nearly the whole difference in route may be attributed to the river canalization. Where the same route is followed the construction merely consists in enlarging the old canal.

Route of the Barge Canal.

In Fig. 1 is shown the route of the Barge Canal. Roughly speaking, from Tonawanda east to Newark the Barge Canal is an enlargement of the Erie, from Newark to Rome it has a new line to take in Oneida Lake and for other reasons to be explained later and from Rome to the Hudson at Waterford, except for a few intermediate cut-offs and the final cut-off at the latter place to lock down into the river, the canal is in the Mohawk River. The Oswego Canal branch of the new Barge Canal is purely a river canalization, as is also the Champlain branch from Waterford up to Fort Edward, beyond which the old Champlain Canal is enlarged.

Starting from the west, the Barge Canal leaves Lake Erie at Tonawanda instead of at Buffalo as before. The channel up the Niagara River to the new entrance is being dredged by the Federal Government. At Tonawanda the new line follows the old up Tonawanda Creek, except that there are several places where short cut-offs are made, to Pendleton, where, still on the old line, the turn toward Lockport is made in heavy cut. At Lockport there are at present five locks dropping the Erie Canal over the 50-ft. ridge known as the "Niagara Escarpment." These will be supplanted by a lift of two locks totaling practically the same height, the only multiple lock on

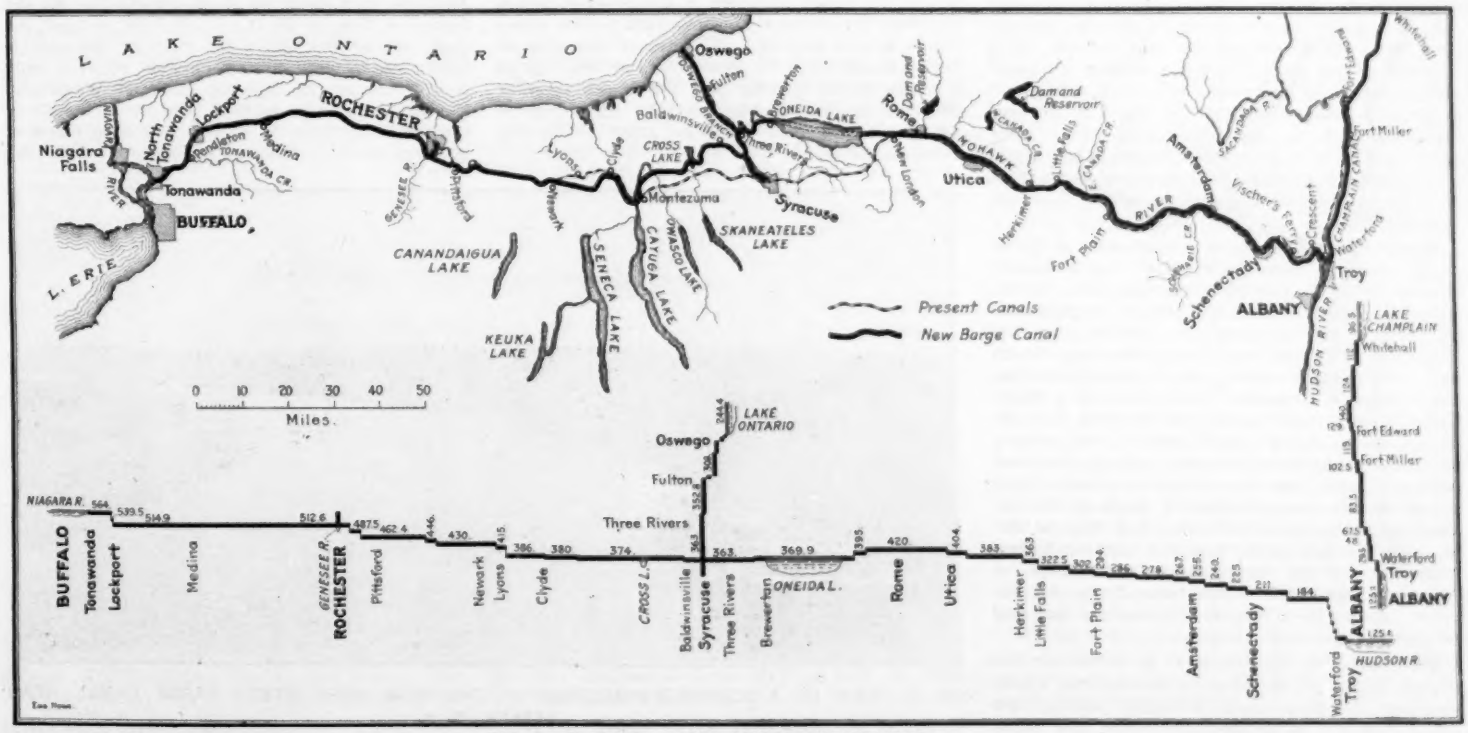


FIG. 1. THE NEW YORK STATE BARGE CANAL.

the entire new line. These locks are in the city of Lockport, and in order to save the great expense of extra land condemnation there, the new set is to be built in the site of the south tier of the present twin locks.

Below the Lockport locks there extends to the east the longest level on the canal, a stretch of nearly 60 miles to a lock just east of Rochester. This stretch goes through a number of small towns in the line of the Erie Canal to a point about four miles west of Spencerport, where the Barge Canal turns to the south to avoid entering the city of Rochester. There is nothing of exceptional difficulty in the construction of the line between Lockport and Rochester except the crossing of a deep gorge at Medina, which is to be made on a large and extremely heavy arch viaduct of 290 ft. span. This arch, which was described in part in Engineering News, March 10, 1910, p. 274, is now under design, but the contract has not been let as yet. At Rochester a small short branch about three miles long is to be built into the city to intersect with the line of the old canal, in order to provide entrance into the warehouses of the city proper. The Genesee River at this point, according to present plans, is to be crossed in a pool formed by a movable dam which can be raised or lowered in cases of flood. On either side of the river the canal is to be protected also by guard gates. Immediately east of the city is one of the largest cuts on the line of the work, some 63 ft. at its greatest depth.

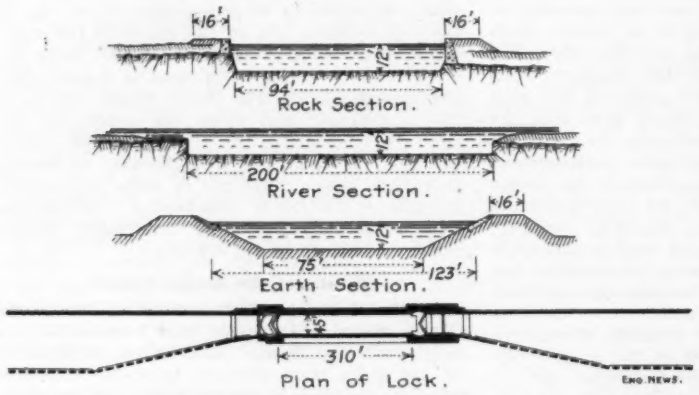


FIG. 2. TYPICAL SECTIONS AND LOCK ON THE NEW YORK STATE BARGE CANAL.

The line of the old canal is met again at Pittsford, which is two levels below the Lockport-Rochester level, and with the exception of the cut-off, to avoid a curve at Fairport, continues on the line of the old canal to Newark. In this section is the Irondequoit valley crossing, where the canal is to be carried on a high embankment made from a hydraulic cut in a nearby sand-hill. In the embankment the channel is made of a concrete trough with stepped wall section sides and a reinforced-concrete bottom. Between Newark and Clyde the design at present calls for a canal running somewhat south of the old line, through a flat district in which the channel is made by partial cutting and partial diking. There is decided objection in the village of Lyons to this route, which takes Lyons off the canal, but so far this objection has not had any effect upon the Canal Board.

Dropping down all the way, as shown on the profile in Fig. 1, the canal proceeds from Clyde eastward to Montezuma alongside of the old canal, but not in its section. From this point east to Rome, as noted before, numerous lakes and streams are utilized for canalization. From Montezuma to Three Rivers the Seneca River, with some of its bends eliminated, is followed. This latter location is the low level of the middle section of the canal. Water is fed to it from the west from the Niagara River and from the east from the Rome summit level through Oneida Lake. Out of this level also descends the Oswego Canal to Lake Ontario, as will be described hereinafter. In the canalization of the Seneca, a small lake, known as Cross Lake, is crossed and a lock is provided around the falls at Baldwinsville.

To accommodate the city of Syracuse, a branch line is to be run from the bend of the canal between Baldwinsville and Three Rivers down through Onondaga Lake into the city.

From Three Rivers to Oneida Lake the Oneida River, with the bends cut out, is ascended, with one lock intervening. Eastward from Brewerton, at the western end of Oneida Lake, the lake is crossed in open water. Very little dredging has to be done on this lake in order to reach the required channel. From Sylvan Beach, the eastern end of the lake, the line is up across open country to the summit level at Rome, where the Mohawk River is reached. The Erie Canal is crossed at New London, where it is about 9 ft. higher than the new line. This section of the old canal is to be retained as a feeder at that point. Whether the old canal between Syracuse and Rome will be retained for possible use has not been entirely decided upon as yet.

The line of the Barge Canal at Rome is to be moved about a half-mile south of the present line and the railway at this point is to be carried south also; in both cases straightening curves in the old alinement. East of Rome the Erie is again crossed and another junction lock is to be built here controlling the flow of the old Black River Canal which runs north from here.

A short distance east of this lock the Mohawk River is reached and from here eastward to the Hudson the Mohawk is used as the main section of the canal, although in a number of places the line, for various reasons, cuts across country in a new section. The summit elevation at Rome is 420, and at Waterford, at the top of the five docks leading into the upper level of the Hudson, the elevation is 184. This drop of 236 ft. is made in 14 locks along or in the Mohawk River.

At the place where the Mohawk enters the canal an extra large section is provided to care for floods and a guard gate to prevent flow toward the west. The river is to be carried here for about three miles and it will then be returned to its channel over a long spillway, with an adjoining guard gate to prevent excess flow to the east. The water-supply of the level comes from reservoirs to the north, which will be described below.

At Utica the first of the downward lockages toward the Hudson is to be placed. All along this section the line is in open country to the north of the Erie and the river, but just above Herkimer the river is again entered, and is held up to level by a Poirée dam. Below this lock there is a pool some three miles long held by the present state dam at Little Falls. Around the falls at this latter point, the new line follows the old through the heavy rock cut to the south of the river, and here is to be built the highest lift dam on the canal, with a difference in level of 40.5 ft. Below the lock the river is again entered and the level is held by a movable crest dam at Rocky River, just above Lock 16 on the profile in Fig. 1. Below this is a short land section and the river is again entered at Mindenville, Lock 16, and from this point east is used entirely as the channel of the canal.

This portion of the canal is merely slack-water navigation of the Mohawk, controlled at suitable points by pools formed by movable dams. These dams, eight in number, are located at Locks 15 to 8 (see profile in Fig. 1), and consist of a series of trusses from which may be suspended heavy curtains, extending down against butting blocks in the river bottom. For ordinary navigation these curtains are down and the water is backed up in pools, the boats passing from upper to lower pools through the locks adjacent to the dams. In the winter, when navigation is closed, or at times of high water or flood, the gates or curtains can be readily raised and the floods allowed to pass down the river. On account of the large flowage area necessitated in this valley by a permanent dam it was absolutely necessary to provide some sort of movable dam along this part of the river, and the type adopted was the result of extensive study abroad, where such devices have been most used.

These dams provide the pools down to Schenectady, and from there east the topographical conditions are such that permanent dams can be built. The first of these dams is at Vischer's Ferry, and the second is at Crescent. Both are concrete dams of gravity section, provided with spillways and gates for flood conditions. At the former a lock of 27 ft. lift is built around the dam, but at the latter the level of the pool is continued through a new cut for about a mile to the top of the five big locks at Waterford. The old canal here takes a long detour south of the river and drops by Cohoes in a long series of 16 locks down to the approximate level of the Hudson, which it finally enters at Albany. The new line cuts off all of this detour and passes almost directly into the Hudson at Waterford through the five locks, aggregating a lift of 135.8 ft. into the level of the river above the state dam at Troy. Through this dam there is a lock of 14 ft. into the lower level at Albany.

FIG. 3. VIEW OF A COMPLETED SECTION OF THE NEW YORK STATE BARGE CANAL NEAR MEDINA, N. Y.

The locks at Waterford are all within a mile section, so that some method had to be taken to preserve enough water for lockage through the series. This has been done by forming a pool

between each two locks. These pools are retained by concrete core walls from the head of the locks to the adjoining hills and in these walls are sluiceways through which the lockage water may be let down to the low pools.

CHAMPLAIN CANAL.—The line of the old Champlain Canal ran from an entrance into the Mohawk River at Waterford up to a summit level about three miles north of Fort Edward, thence down into Lake Champlain at Whitehall. The summit level was served from the Hudson River at Glens Falls through what is known as the Glens Falls feeder. The new Champlain Canal is practically a canalization of the Hudson River up to Fort Edward, leaving the river at that point for an overland line, an enlargement of the old section to Whitehall. In the canalization of the Hudson, fixed dams are used. In all but two cases these dams are already in the river. The only new structures are about three miles north of Waterford and at Crocker's Reef, just south of Fort Edward. The Glens Falls feeder will be retained to supply the summit level of the new Champlain Canal. The location of the locks is shown on the profile in Fig. 1.

OSWEGO CANAL.—The present Oswego Canal extends north from Syracuse to the Seneca River, which is partially utilized on the way down to Lake Oswego. The river is variously called the Oneida, the Seneca and the Oswego, depending upon the branch in question. The new canal will be entirely a canalization of the river from a junction with the Barge Canal line at Three Rivers down to the lake, the water-supply coming from the Syracuse level of the Barge Canal. In this canalization the pools for the eight locks will be held by fixed dams, some of which are now in existence and three of which will be built new.

CAYUGA AND SENECA CANAL.—In the referendum vote at the November election in 1909 the people of the state approved a bond issue of $7,000,000 for the construction of an addition to the Barge Canal, along the line of the present Cayuga and Seneca Canal, connecting the two lakes of those names with the Erie Canal. Surveys have been made of this new route, but as yet no plans have been announced. It is expected that some progress in the design will be reported very soon.

Sections.

In general, there are to be three sections on the canal—the rock section, the river section and the earth section, all three of which are shown in Fig. 2. As noted in the first part of this article, the Barge Canal Act calls for a depth of at least 12 ft. and a bottom width of at least 75 ft., with a cross-sectional area in the ordinary sections of at least 1,125 sq. ft. The rock section is a rectangular section 12 ft. deep and 94 ft. wide, either in plain rock with vertical walls, or in partial rock cut and fill, in which case concrete retaining walls are to be built to take the place of side rock walls. The river section requires a 200-ft. width, 12 ft. deep, with vertical sides. The earth section has a 75-ft. bottom width, a 12-ft. depth and 2 to 1 side slopes, making a total water level width of 123 ft. These earth sections are to be protected with riprap extending from the top of the slope well down into the water. However, in some sections which have been completed, and in which the water has been allowed to stay through one season, there has been a notable slipping of this upper riprap, so that it is quite probable that in the earth sections a riprapping to the bottom of the slope will be required. It will be noted that no tow-paths are provided in any of the sections, as mechanical towing is to be used entirely on the canal.

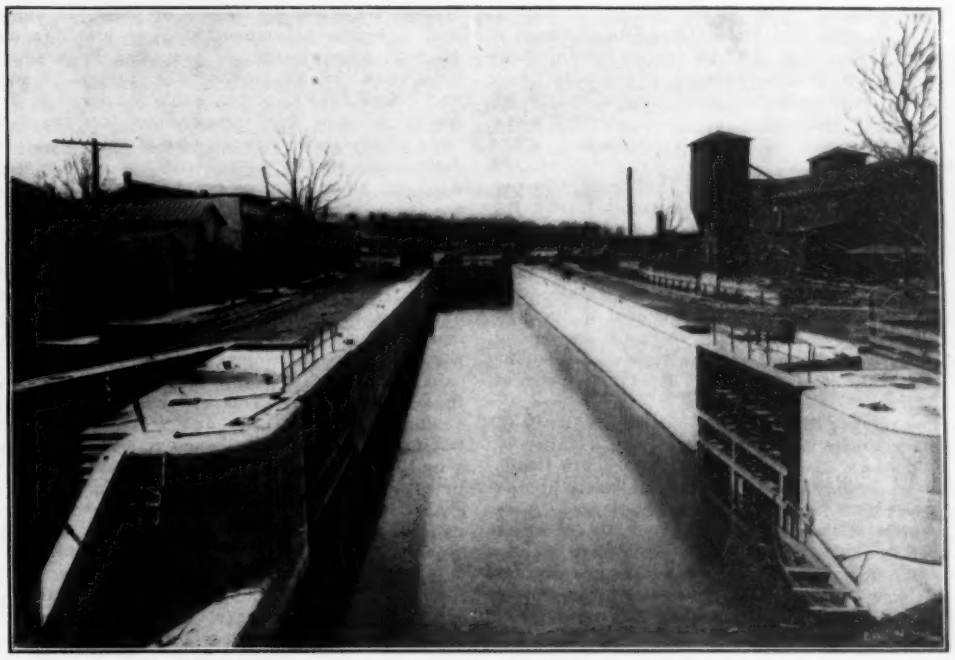


FIG. 5. VIEW OF ONE OF THE COMPLETED LOCKS, AT BALDWINSVILLE, N. Y.

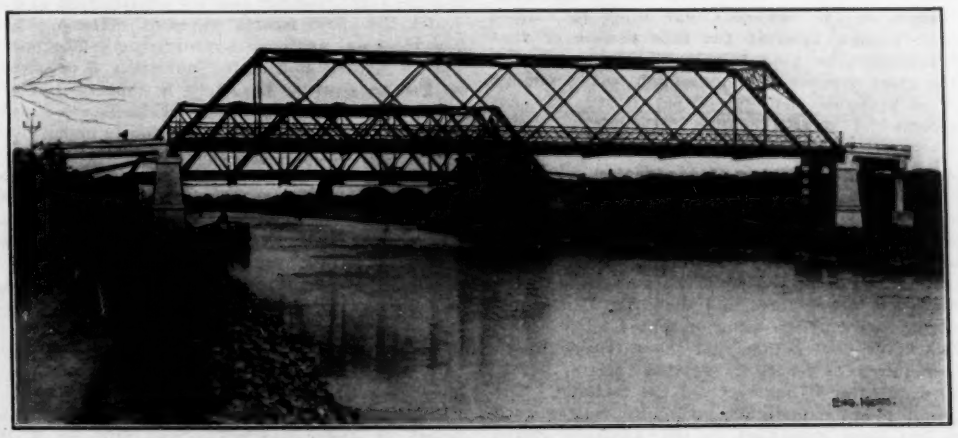


FIG. 4. VIEW SHOWING AN OLD AND A NEW BRIDGE; SHOWING THE DIFFERENCE IN SIZE BETWEEN THE ERIE AND THE BARGE CANAL.

Locks.

As originally designed, the locks were to be 328 ft. long and 28 ft. wide, with a depth over the miter sills of 11 ft. In 1905, after considerable discussion, the Canal Board changed the size of the locks to a width of 45 ft. and a depth of 12 ft. over the sills. Previous to this action, the Board of Advisory Engineers strongly advised the Canal Board to increase the depth of the canal sections to 14 ft. instead of the 12 ft. finally decided upon, but, in spite of the fact that all of the engineering talent in the service of the state was in favor of this enlargement, the Canal Board, consisting purely of political appointees or elective officers with no engineering training, decided against the enlargement and would only permit the locks to be changed as noted above. As a result, if in the future it is thought necessary to deepen the Barge Canal to accommodate large barges, the cost of deepening locks, built of heavy monolithic masonry, will be tremendous. It is estimated that the locks as now built will easily pass a 2,600-ton barge and that the canal is more properly a 2,000-ton barge canal than the 1,000-ton canal it is usually designated.

Along the line of the canal there are 53 locks, ranging in lift from 8 ft. to the mammoth lock of 40½ ft. at Little Falls. In addition there are 7 small locks at intersecting canals and 2 large guard locks. These are all built of concrete with, in nearly every case, steel miter gates at both upper and lower openings. In the case of the lower gate at Little Falls, the head to be held was so heavy that the designers decided to install a vertically-moving gate instead of the standard miter type. In every case but two the feed to the locks is through gate control culverts, for which special gates have been designed in the Bureau of Bridges at Albany. In one case, the last lock at Oswego, there has been installed a siphon lock after the type used somewhat in Germany, in which the water is led into the lock chamber through a reinforced-concrete tube bent up to form a siphon and controlled by a small air-exhausting valve immediately alongside. In the Little Falls lock, although the regular gate valve is used to start the filling of the lower chamber, the siphon principle is utilized to complete the performance.

All of the locks are to be operated by power. Designs have been made in some cases to install a wheel in the lock proper which will generate power, through an electric motor, to operate the gates. In other locations, where there is a permanent dam, it is expected that power-houses will be built to operate the locks and to transmit power to other adjacent locks or for other purposes. On the Mohawk, where the movable dams preclude continuous flow, power will have to be brought in from some outside source.

At every lock guard gates are provided in the form generally of large beams swinging out from an inclosure in one lock wall across the lock just above the water surface.

Water-Supply.

As has been noted, there are three main sources of water-supply to the canal system: Lake Erie, reservoirs in the mountains or hills north of the middle section of the canal and the Hudson River at Fort Edward. In addition to these main sources of supply there are the natural river courses and lakes in which the canal runs for a considerable distance and the numerous minor feeders built to supply the Erie Canal. This old canal was built as a rule on a high

level so that minor feeders had to be cut back all along the line to the sources of supply on the higher level. On the contrary, the Barge Canal has followed as far as possible the low level lines on which the water runs, so that the necessity for feeders is not so great. However, as a precautionary measure, it is probable that most of these feeders will be retained as an additional water-supply.

The western level down to the intersection of the Seneca River will be supplied from Lake Erie feeding directly through Tonawanda Creek and the canal, covering a distance of nearly 100 miles. An easy grade has been provided along this portion and the supply is figured to be quite sufficient without utilizing any of the old feeders.

The middle section is to be supplied from the upper Mohawk River down the valley in which is the old Black River Canal, from existing feeders south of the Erie Canal between Syracuse and Utica and from West Canada Creek. The first of these sources is to be stored in the new Delta Reservoir, just north of Rome, the second in a number of small existing reservoirs, and the last in the new Hinckley Reservoir north of Herkimer.

The Delta Reservoir is formed by a 70-ft. gravity concrete dam thrown across a valley of the Mohawk River, about five miles above Rome. The reservoir formed by the dam backs up the valley for a distance of some miles and covers the town of Delta and the line of the old Black River Canal, which has been changed in line to pass around the reservoir. The drainage area of the river is about 137 sq. miles and the reservoir area proper is 4⅓ sq. miles, with a capacity of 2,750,000,000 cu. ft. The water impounded in the reservoir is to be passed over a spillway and through sluice-gates into the Mohawk River again, there to pass into the canal, as needed, just east of Rome.

The Hinckley Reservoir, which has not been started, is in the drainage basin of West Canada Creek, with a drainage area of 372 sq. miles, an area of 4.46 sq. miles and a capacity of 3,445,000,000. It is to be held back by a 75-ft. dam, an earth section with concrete core wall, spilling through natural and built sections canal into Nine Mile Creek and thence into the Barge Canal below Rome. This diverts the water of West Canada Creek which ordinarily would reach the canal on the down slope toward the east at Herkimer into the summit level where it is needed. In addition to being a water-supply reservoir this is expected also to serve as a flood-control. West Canada Creek is very subject to high floods which cause much damage below Herkimer and these should be controlled or diverted to a safe place under the new system.

The down slope is amply supplied with water from the Mohawk and from its tributaries. The Champlain is supplied directly from the Hudson and from the Glens Falls feeder.

Movable Dams.

In the canalization of the Mohawk below Herkimer it has been noted that the successive pools are to be held by movable dams. As originally designed this section of the canal was to have been in slack-water navigation, maintained by a series of permanent dams across the river, but the severe floods that periodically come down the Mohawk persuaded the engineers that some other method of control should be devised. In addition the valley of the Mohawk is very fertile and rich and the condemnation of land required by the pooling of water behind large permanent dams would have been enormously expensive.

For these reasons, it was decided to close the river with movable dams, thrown only across the channel and not up onto the side slopes of the valley as would have been required in a permanent dam. These dams are to be kept closed during periods of normal flow, backing up enough water to provide sufficient depth in the pool, but in the winter when the canal is closed they will be open to let the flow of the river down unobstructed. In time of floods the dams will act as control gates, either to let water out gradually, or, what is more likely, to let it flow through the channel unobstructed.

The type of dam decided upon for the Mohawk is known as the bridge dam with Boulé gates. It consists of a series of ordinary looking bridge trusses, upon concrete piers, carrying hinged from the down-stream lower chord a series of steel frames which swing down into the river, and these butt against concrete and cast-iron blocks embedded in the river bottom. On these frames are lowered two sets of gates, an upper and a lower, to control high or low flow as needed. These gates are controlled by a small hoist that travels across the bridge trusses and raises or lowers the gates as desired. To let a moderate flow through the dam the two tiers of gates are separated or if need be lifted entirely up on the truss. In times of excessive flood the hinged frames can be swung up under the truss clear of the water in the river.

Eight of these dams are to be built on the Mohawk River and one to provide the pool crossing the Genesee River at Rochester. Elsewhere on the canal five other movable dams are to be built, but they are for guard purposes and are more properly called gates than dams. At Baldwinsville, there is in operation now an automatic dam, at the end of a concrete dam there across the Seneca River. This automatic dam is so arranged that it opens and lets through the water of the pool above when it has reached a height 1 ft. above the permanent concrete dam, thus preventing the pool from rising above a given elevation detrimental to the surrounding shores. At Waterford just above the locks there is provided a guard dam and adjacent sluiceway to prevent boats getting away and being carried down to the flight of locks. This dam is in the form of the segmental gate and is one of the largest of this type ever built.

The fixed dams are in every case of concrete masonry of gravity section, but in one case, the Rocky Rift dam on the Mohawk, there is a movable crest on top of the concrete section to regulate flow.

Bridges.

A minimum clear headroom of 15 ft. has been maintained under all of the fixed bridges across the canal and where grades or other local conditions prohibited a fixed bridge of that clearance, movable bridges have been installed. In the main these movable bridges are of a type similar to that now over the Erie Canal in most of the cities, a horizontal lift, though other types have been installed in places.

Just at present there is a movement in Syracuse in favor of making that city a lake port, via the Oswego Canal to Lake Ontario. To do this would require that every one of the many bridges on the Oswego Canal either be carried high enough to clear the lake vessels or that lift bridges be placed instead. On account of the great expense attendant upon such a change it is probable that the Canal Board will not recommend such a change, although no action whatever has as yet been taken.

Engineering Organization.

Under the law the State Engineer and Surveyor is in charge of the canal work, supervised by the Advisory Board of Consulting Engineers and the Canal Board. All maps, plans, specifications and detail estimates must be made by the State Engineer's force and submitted to the Advisory Board before being presented to the Canal Board for final action, and the Advisory Board is required to report its opinion thereon within 30 days after it has received the material. The Canal Board cannot act upon any matter until it has been submitted to the Advisory Board and reported upon by it, or until the time for the Advisory Board to report shall have expired. The Canal Board is composed ex-officio of seven elected state officers and contains but one engineer, the State Engineer and Surveyor, unless some of the other elective officers happen to be engineers by profession; the Advisory Board has been and is composed of eminent engineers, thoroughly qualified to supervise the design and construction of the canal.

The construction of the canal is under the State Engineer and his Special Deputy, with three Division Engineers, one each for the divisions as marked on the map in Fig. 1, and a number of Resident Engineers and minor employees. In addition the office at Albany is divided into a number of bureaus, each devoted to some especial branch of the design of the canal. In all about 600 engineers are employed on the work, and it is estimated that on Dec. 1 last 6,250 men were under employment by the contractors.

One of the novel features in the Barge Canal Law is the provision that the Superintendent of Public Works, who has the letting of bids in charge, may make no award that is based on any bid, the total of which exceeds by more than 10% the gross amount of the engineer's estimate, or when the price bid for any item is more than 20% in excess of the estimate for such item, unless such award has been duly approved by the State Engineer and the Canal Board. This leads to a very close estimate being made by the engineers, although at the same time it probably is responsible for some of the difficulties in getting bids on the work. As an instance of the close estimating and bidding, the engineers' estimate on Contract 90, just let, was $180,630, and the two bids upon it, $179,982.95 and $178,197, respectively, a total variation of about 1.3%.

Progress of the Work.

The first work on the Barge Canal was started on April 24, 1905. At the end of that year $330,120 had been paid over to contractors and the total at the end of each of the next fiscal years reached $1,042,926, $3,257,461, $8,701,323 and $16,291,325. This last figure represents the total amount paid out since the beginning of the work up to Sept. 30, 1909, the end of the last fiscal year, on all of the contracts; the amount of work done is slightly more on account of the percentage held back until the completion of each contract. On April 1, 1910, of the 414.6 miles of canal on which work must be done, 333.6 miles were under contract, at a total figure of $55,023,391, 48.2 miles had plans completed, 26.4 miles had plans over 75% completed and 6.4 miles were still under design. From these figures it would seem that although the work of design is practically completed, the construction is not more than fairly well started. The estimated cost of the canal is approximately $100,000,000, and of that amount at the end of April of this year, four years after the first dirt was moved, the sections under contract had a value of $57,646,659, of which $17,929,955 had been paid over.

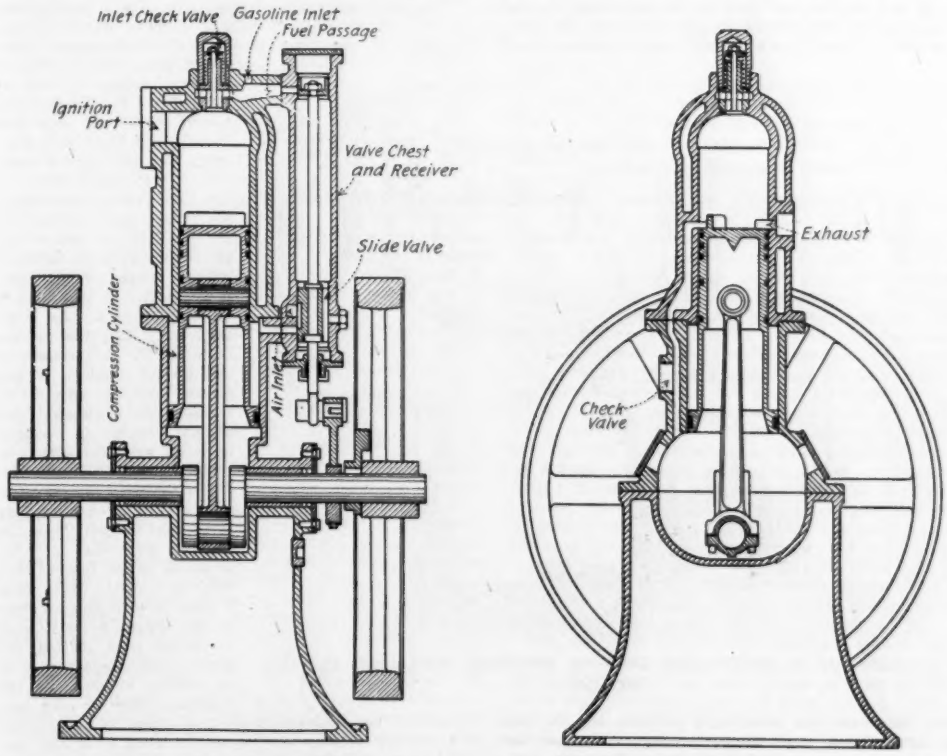
The progress of the work is not fairly represented by these figures. In the first place, the cost of engineering and land condemnation have to come out of the total $100,000,000, thus bringing the total contract cost for construction alone, which the above figures represent, materially below the total available appropriation. The mileage data, then, is a better indication of progress, so far as starting the work is concerned, than the payment totals. This mileage figure shows that about 80% of the construction is under contract. On the other hand the progress of the contracts can only be shown by the payment figures and these indicate that only about 30% of the work under contract has been completed. The Barge Canal authorities have explained why the work of letting contracts has progressed so slowly; the difficulties of seasonal construction, the obstruction in the way of the old canal and the uncertainty of changing administration are the main reasons why contractors have hesitated to bid upon the work and why the contracts let have been so slow in covering the entire canal. But that time has passed and nearly the whole length is under contract; from now on it is merely a question of construction. This, too, is hampered by the first two of the same objections as are noted above and will continue to be so hampered.

However, it is a well known fact that construction acquires momentum as it proceeds and that the first quarter of the work is the hardest to complete. This is certainly the case with most of the work along the Barge Canal. The heavy structures are nearly all well advanced, the locks and movable dams will be practically all completed before the present season is over, and one, at least, of the big water-supply reservoirs will be cleaned up before cold weather sets in. The

work remaining to be done, though costly, is fairly easy of accomplishment. For instance, practically all of the dredging in the Mohawk is yet to be done, but the work has been held up pending the completion, this season, of the movable dams along the river, which will back up pools in which the dredges, mostly hydraulic machines, can work to great advantage and with great rapidity. The progress of the Barge Canal has been slow, but it is an unwieldy system, extending over 400 odd miles of territory, divided into nearly a hundred contracts, hampered by the peculiarities of a political controlling body and surrounded by the proverbial red tape of officialdom. It has been an unreasonably long time in starting, but it now seems well under way and with a future much more hopeful than the past has been successful.

A Novel Two-Cycle Explosion Engine.

The design of engine shown in the accompanying figures is the result of attempts to secure a type, for small, heavy, stationary units, which would secure the theoretically greater capacity of a two-cycle engine over a four-cycle unit of the same general dimensions and weight and



Longitudinal Section. Cross Section.

VERTICAL SECTIONS THROUGH A NEW TWO-CYCLE EXPLOSION ENGINE.
(Designed by Mr. C. A. Dawley, Jun. Am. Soc. M. E., New York City.)

without losing the greater reliability of the latter for such service.

Air (but not a fuel mixture) is compressed in the crank case much as in any two-cycle engine. This air, at a pressure of some 4 lbs. per sq. in., is used solely for blowing out the spent gases in the cylinder at the end of a power stroke. Air (or a lean gas or a mixture of a rich gas and air) is compressed into a long valve chest, serving as a receiver, and held there at about 10 lbs. per sq. in. maximum pressure. This operation is performed by an auxiliary cylinder, the piston for which is a part of the working piston of the explosion cylinder. The pressure on this stored charge of air or mixture is utilized to place the fuel charge in the cleared cylinder just as compression is about to start.

The cycle of operations may best be understood after an examination of the accompanying figures. Here the piston is shown at the end of a down stroke. Air has been admitted to the crank case, during the preceding upstroke, through the check valve shown. The scavenging ports have been opened near the end of the down stroke so that part of the spent gases has naturally escaped and most or all of the rest has been swept out by air from the crank case. The deflecting wing on the end of the piston has prevented a short circuit of the air to the exhaust port and any consequent pocketing of spent gases in the upper part of the cylinder.

On the down stroke also, air, or the mixture of gas and air, has been admitted from the air inlet to the annular auxiliary cylinder through the slide valve shown at the right.

As the upstroke now commences the upper part of the slide valve first shuts off the supply of air or mixture from the auxiliary cylinder and opens up a passage from the valve-chest receiver to the working cylinder. The pressure, already stated to exist in this valve chest, forces the fuel charge into the working cylinder as compression is about to start. The flow of fuel charge continues until the compression balances the receiver pressure when the charge is trapped, for further compression, by the inlet check valve shown at the top of the cylinder. After the fuel charge has been admitted to the working cylinder, the lower part of the slide valve opens the compressing cylinder to the receiver. Meantime as the upstroke proceeds the auxiliary cylinder continues to compress, into the receiver, the air or gas mixture required for the next charge. The receiver pressure is much less than that of compression in the working cylinder so that the inlet check valve remains closed. The supply in the valve chest is completely trapped on the down stroke of the slide valve.

The explosion takes place at the usual time, being caused by any device found best adapted to the conditions of engine service.

In the case of a gasoline engine, the gasoline would be pumped to the inlet passage and sprayed into the cylinder by the air passing from the valve chest. For an engine using a producer or blast-furnace gas, it is not necessary to dilute the gas in taking it into the auxiliary cylinder, there being sufficient air in the cylinder after scavenging to insure proper combustion.

An experimental single-cylinder engine, of this type, having a bore of 5 ins. and a stroke of 6 ins., and weighing 1,050 lbs., was recently tested in the mechanical engineering laboratories of Sibley College, Cornell University. It was found to develop 6 HP. at 360 r. p. m. No unusual economy of operation was expected and the amount of fuel was found to be the same required by any good engine of this small, heavy type—about 1 pint per HP.-hr. The gain has been in capacity. Comparison of small, heavy, single-cylinder, slow-speed, four-cycle engines, rated at 6 HP. and now on the market, shows that the average weight is some 1,900 lbs., in contrast to the 1,050 lbs. of the experimental engine noted, which is of the same type and intended for the same service. Assuming that it might cost 10 cts. per lb. of finished weight to manufacture these small machines, the 800 lbs. saving in weight would indicate a total saving of $80 in the cost of the engine, or a saving of some $13 per horsepower. These figures would apply, of course, to such "jack-of-all trades" engines only.

The design here described has been patented by Mr. C. A. Dawley, Jun. Am. Soc. M. E., of New York City, from whom this information has been obtained. The development of the engine is being carried on by the Newcycle Motor Co., of 39 Cortlandt St., New York City.

The Shockless Jarring Machine; a Foundry Sand Packing Device.*

By WILFRED LEWIS,† M. Am. Soc. M. E.

The title of this paper may appear to the casual reader like a contradiction of terms, but to the foundryman who has hitherto attempted to ram sand by the jarring process, the term "shockless" will be understood to apply only to the foundation or support on which the machine stands.

A jarring machine is essentially a sand-packing machine, capable of ramming any mold, large or small, in a minute or less time. The sand is rammed, as it should be, densest at the surface of the pattern and of decreasing density above, thus favoring the escape of gases when the mold is poured. The packing of the sand results from impact between the table on which the mold is carried and the anvil on which it drops. Various means may be used to lift the table and let it drop, but in foundry work compressed air has come to be generally preferred for its convenience as a medium for the transmission of power and also for the simplicity of the machines resulting from its use. The jarring machine is not universal in its application nor should it be used without judgment and discrimination. Due regard must be given to the construction of the pattern so as to permit a flow of sand chiefly in one direction, and to withstand successfully the shock of impact in ramming. But, for the broad field of work adapted to its use, there is nothing comparable to the jarring machine as a saver of time and money.

Molding Machines.

Jarring machines have been in practical use for many years without attracting much attention. Like all other types of molding machines, they have never been made, until quite recently, for large, heavy work beyond the strength of one or two men to handle. It was quite natural that the molding machine should begin its development in a small way on small work; as the field has widened it has been seen that the possibilities for saving time and money in the foundry have increased with the size of the work adapted to machines.

Anyone who has watched a bench molder fill his little flask, ram it in a few seconds with a butt rammer in each hand, then roll it over and draw the pattern with the dexterity of an artist in legerdemain, can appreciate the difficulty of helping him in his work by any mechanical means. Yet the old-fashioned hand squeezer saved some of the ramming time, and the power squeezer saved a little more, but not so much in time as in the strength of the operator, keeping him fresh, with steady hand and eye, for the delicate work of drawing patterns and setting cores. Pattern guides were then devised to assist in drawing patterns, and vibrators were invented to free the pattern from the sand without appreciably enlarging the mold.

The use of molding machines on small work has resulted in a substantial saving in the cost of molding, in less wear and tear on patterns, and in greater uniformity in castings. The saving in weight of the castings due to the use of a vibrator is sometimes an item that soon pays for the installation of the machine. The hand squeezer is, of course, limited in its application to what can be done at one effort by one man, and for larger work power squeezers have generally been employed. But when large molds are squeezed by power,

*From a paper presented at the spring meeting of the American Society of Mechanical Engineers, at Atlantic City, N. J., June 1-3.
†Philadelphia, Pa.

more or less trouble is encountered in the distribution of pressure on the sand. At one time an effort was made to overcome this difficulty by means of a water-bag placed between the sand and the squeezing head. Better results were obtained, however, by judicious tucking in deep pockets, by heaping the sand over deep places, and by scooping it out over high points in the pattern; but the main difficulty in squeezing deep molds lies in the fact that the sand is generally moved against the pattern instead of the pattern against the sand. This results in the greatest density of sand being away from the pattern, next to the squeezing head, and not where it should be, next to the pattern.

As shown by Harris Tabor's experiments,* presented in 1892, the friction of sand on the sides of a deep flask may carry a large part of the pressure on the squeezing head. To avoid this difficulty, bottom-ramming machines have been employed, which move the pattern against the sand, but this method contemplates a definite, predetermined movement of the pattern to produce a mold of the density desired, and is subject to variations not easily controlled. Bottom ramming has, therefore, not been adopted to any great extent, and power squeezers have usually been limited in application to flasks not more than 2 to 3 ft. on a side by 1 ft. deep. Such machines, when designed also for pattern drawing, are comparatively expensive and have marked for a time the limitations of machine molding.

During recent years however, while the power squeezer and the split-pattern machine were completing their development, the much neglected jarring machine has grown steadily in favor and in size, until to-day there would seem to be no limit to its capacity. These machines are simple in construction and effective in operation, while on large work the saving to be effected by their use probably exceeds that by all other types of molding machines combined. I say on large work, because on small work jarring machines cannot compete with power squeezers of the same capacity, except perhaps in a few special cases where the work is deep.

The value of any machine depends of course on what it can save, and what it costs to effect that saving; a problem to be worked out in every instance by a systematic time study of all the operations embodied in producing a given result.

On the other hand, the interest on the investment, the depreciation of the machine and the consumption of power, must be accounted for; and in addition to all these, the damage that may be caused by the action of the jarring machine upon finished molds, or even upon buildings in the neighborhood, and the annoyance caused by noise and ground waves generally. This damage and annoyance has increased steadily with increase in the size of the machines and in the weight of the loaded table. To meet these serious objections, various expedients have been adopted, among which may be mentioned a reduction in the stroke or drop, and a more or less resilient bedding for the anvil.

PRINCIPLES GOVERNING DESIGN.—The above palliatives, however, left much to be desired until the shockless jarring machine, with its anvil rising up to meet the falling table was developed. This has eliminated the chief objection to jarring machines. It is the object of this paper to elucidate the principles upon which it works and to establish its claim to superior efficiency in the consumption of power.

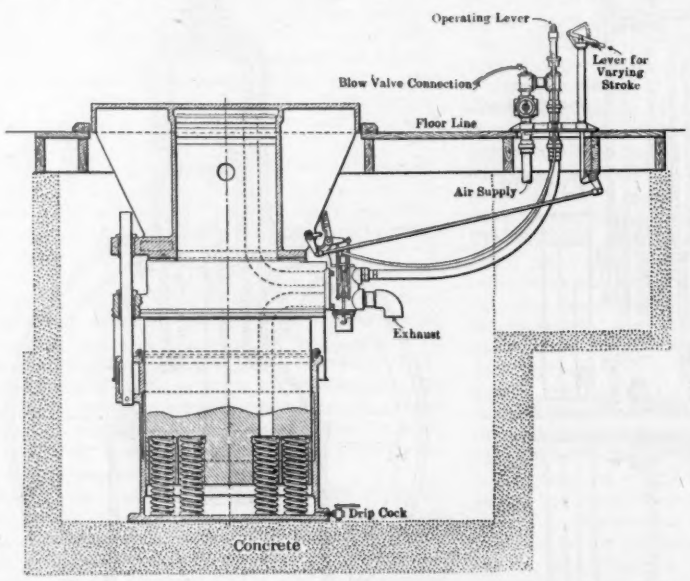
In the first place, it must be admitted, that although the packing of sand by the jarring process is very quick and effective in producing results, it is not very efficient under the most favorable conditions, as far as the expenditure of power is concerned, and that under certain conditions the efficiency may be reduced to zero. In the process of ramming, the density of sand is increased 25 or 30%, and if a steam indicator were attached to the cylinder of a power squeezer, it may be questioned whether it would ever show over 1,000 ft.-lb. per cu. ft. as the work actually done on the sand in squeezing it to proper density. Of course a great deal more power than this would be consumed in the use of water or air as a working fluid, but the work put into the sand would in all probability not exceed 1,000 ft.-lb. per cu. ft.

To produce the same effect by jarring, the sand might be raised to a height of 4 ins. and dropped upon an anvil 30 times. But to the weight of the sand must be added the weight of the table and flask, and the excess sand used as an aid in ramming. The first blow struck will cause the greatest flow of sand and will do the most work upon it, while each succeeding blow will increase the density, but will do less and less work until, after a certain number of blows, the sand will remain at a density corresponding to the drop. When this point has been reached, the continued action of the jarring machine simply wastes power and produces no effect. The jarring machine is therefore more efficient during the earlier stages of the process than it can be when the condition of maximum density is approached; and for this reason, the longer the stroke the greater will be the efficiency. Other considerations of a practical nature, affecting the elasticity or durability of flasks and patterns and of the machine itself, necessarily tend to limit the stroke, however, so that in practice it varies from ⅝-in. on some machines to 4 ins. or more on others with an average of perhaps 2½ ins.

*Trans. Am. Soc. M. E., Vol. 13, p. 537.

In such machines, the most important consideration is solidity of construction and freedom from vibration of the jarring table. Otherwise the sand will become broken or laminated and the mold will be liable to fall apart in handling. Although lightness of construction in the jarring table is obviously desirable from the standpoint of economy in power, it is certainly not desirable from the standpoint of making perfect molds. The good results which accompany the stronger and stiffer table really cost less and it consumes less power in the end, because there are no failures necessitating repetition, or molds to be thrown away. The importance of solidity in the jarring table will be appreciated after a consideration of the character of rammed sand. It has a certain amount of elasticity, a good deal of resistance to further compression, and some tensile strength, which of course is easily overcome. There must, therefore, be no movement between the pattern, sand and flask, tending to pull the sand apart, and of sufficient amplitude to cause fracture, and no lateral movement tending to slide one layer of sand over another. Such fracture or lamination may be caused by badly fitted pattern boards, flimsy patterns, or crooked flasks not properly bedded, but a light and flimsy jarring table that can be easily warped out of shape will augment the difficulty, and effectually prevent the success of good patterns carefully mounted in strong and firmly bedded flasks.

In the molding machine to be described, the table adopted has been formed in one piece with the jarring cylinder, as shown in section in the accompanying figure. This table has great depth of beam, and the metal is distributed as it should be for economy of cast iron, in a broad expanse of plate on the tension side, and a smaller mass around the cylinder on the compression side, where the blow is struck. Radial ribs connect the tension and compression sides of the beam, forming a table of enormous strength and stiffness to distribute the central blow of impact equally in all directions. A table of this type is really stiffer than some of the anvils on which other tables are made to drop. At any rate, there is no perceptible vibration of the table when it strikes its anvil, or rather the buffer ring of leather, or other non-resilient material, interposed to relieve the sharpness of the blow and to reduce the noise. This buffer also helps to reduce vibration and rebound, by reducing the intensity of the force of impact. It is not, however, the rebound of the table from its anvil that injures a mold, so much as the rebound of the flask and sand from the table. Solidity of contact between table, pattern board and flask is one of the most important elements for the successful working of a jarring machine; yet this detail rarely receives the attention it deserves, and not unfrequently a machine is condemned for this reason, which is no fault of its own.



SECTION OF A SHOCKLESS JARRING MACHINE HANDLING 25-TON MOLDS.

As already stated, unlimited power may be expended in jarring sand to any given density; and since there is a certain maximum density corresponding to any given drop, it is also quite evident that efficiency increases with the drop, and decreases with the dead weight handled over and above the weight of sand used. But a certain amount of dead weight is inseparable from the process, and for this reason a heavy machine may not be used to its best advantage on light work. Nevertheless, with air as a working fluid the benefit gained by expansion on light work offsets to a great extent the loss from the greater proportion of dead weight carried, giving to the jarring machine which uses air expansively in its cylinder quite a wide range of capacities, under approximately uniform efficiency as far as the consumption of air per cu. ft. of sand rammed is concerned. But it is not only the air consumed in lifting the loaded table that may not be utilized to the best advantage. At the instant when the loaded table strikes its anvil, the sudden change in the velocity of the table, whatever that may be, measures the pressure of impact, and the ramming effect is measured by the square of that change in velocity, which is proportional to the energy absorbed, part of which is utilized in ramming sand. Therefore, the greater the change in velocity at the instant of impact the greater the ramming effect, and by the laws of impact, the heavier the anvil the better. Efficiency in a plain jarring machine naturally increases with the weight put into the anvil; but since the cost of the machine depends very largely upon the weight of cast iron or concrete used, the weight of the anvil is generally limited to that of the loaded table. When the anvil is bedded on rock, it becomes practically of infinite weight, and capable of developing the maximum ramming effect for any drop given to the table. A rock bottom does not, however, eliminate the destructive ground waves, and often facilitates their transmission to unusual distances. To mitigate the effect of these shocks, the practice has been to bed the anvil on a timber cribbing, after the manner employed for steam hammers.

The anvil so cushioned when struck by a loaded table of its own weight will suddenly acquire one-half of the velocity of the table at the instant of impact, after which both table and anvil will be brought to rest by the yielding resistance of the timber cribbing; they will then be returned by its elasticity to their normal position. The loaded table, in this case, loses at the instant of impact only one-half of the velocity it would lose by falling upon an anvil of infinite weight, as exemplified practically in an anvil founded on rock. As a result, the retardation of the table by the compression of the wooden cribbing is less intense and less effective in ramming sand, although this second change in velocity no doubt has some effect, especially in the earlier stages of the ramming process while the sand is comparatively soft. Nevertheless the initial change in velocity, between a loaded table and a floating anvil of equal weight, is only half as great as the change in velocity of a loaded table falling the same distance upon an anvil of infinite weight; and the ramming effect in the first instance, being measured by the square of the change in velocity, is only one-quarter as much as in the second case, where the whole energy in the falling mass is immediately absorbed.

An anvil cushioned upon a wooden crib may be considered as a floating anvil, in which the supporting medium is very dense and highly resistant, but in which also the resistance to compression is trifling compared to that of rock. The stiffness of such an elastic bedding for an anvil might be estimated from the anvil movement, of which no data are at present available; but, however effective it may be in the initial stages of the jarring process, it can have but little, if any, effect upon the final stages after the sand has been rammed to a density in excess of that corresponding to such elastic resistance. It may be said, without hesitation, therefore, that anvils cushioned upon wooden cribbing are much less effective than anvils founded in rock, and that such anvils, equal in weight to the loaded table, have in the final stages of the jarring process a comparative efficiency of only 25%. We shall presently see how the anvil in the machine to be described compares in efficiency with the usual type of anvil mounted on a wooden crib.

The Shockless Jarring Machine.

The shockless jarring machine consists, in its usual form, of a jarring table mounted upon an upstanding plunger forming the anvil, which in turn is mounted in a cylinder base and supported upon long helical steel springs. Compressed air, as the working fluid, is admitted through an automatic valve, under hand control, attached to the plunger or anvil base, and passes first into the jarring cylinder to raise the loaded table. At some predetermined point in the table movement, the

air is automatically cut off from the cylinder, and while the valve is reversing, the confined air will expand and lift the table further from its anvil, provided its initial pressure exceeds the balancing pressure due to the weight carried. Then, when the operating valve completes its reverse movement the air from the jarring cylinder may be exhausted into the atmosphere, but preferably it passes from the jarring cylinder to the anvil cylinder beneath, and the table drops by gravity against the reduced pressure in its cylinder. At the same time, the plunger base or anvil is relieved of a considerable part of the load carried by its supporting springs, which immediately expand, giving the anvil an upward velocity to meet the falling table. When air is expanded from the jarring cylinder into the anvil cylinder, this upward velocity of the anvil is augmented and the falling velocity of the table is somewhat retarded, but in any case the momentum of the rising anvil is substantially equal to that of the falling table at the instant of impact. As a result, both table and anvil come to rest with great jarring or ramming effect upon the sand, but without shock or jar upon the foundation or any surrounding material.

When the air from the jarring cylinder is discharged at once into the atmosphere the momentum of the falling table may somewhat exceed that of the rising anvil at the instant of impact; but when this air is expanded into the anvil cylinder it compensates more or less for the loss of spring pressure as the anvil rises, and in this case the momentum of the rising anvil may exceed that of the falling table at the instant of impact. The difference, however, need not be very pronounced, and simply results in a slight initial velocity of the table and anvil at the beginning of the next stroke.

The advantage of the second expansion is two-fold; it utilizes the potential energy of the compressed air in augmenting the momentum of the anvil, and at the same time it checks the acceleration of the table due to gravity and holds it in contact with the load upon it while falling. Otherwise a poorly fitted pattern board or flask may tend to spring away from its support while falling and cause lost motion, productive of a bad mold. For the same purpose, when the air is discharged directly from the jarring cylinder, a long compression spring between the jarring cylinder and its plunger may be introduced with good effect. In several instances such springs have been made to carry half the weight of the table with 8-in. compression. They assist in lifting the loaded table, and retard its acceleration in falling; and by their use the lifting capacity of jarring tables may be considerably augmented. Their chief purpose, however, is to retard the falling table and hold the pattern flask and sand firmly against it in readiness for the coming blow. With such a spring, the action of the table is, of course, somewhat slower in falling and more stroke is required to produce a given velocity of impact. On the other hand, the table rises faster and runs further to produce a given blow, and the increased stroke reduces the percentage of clearance space to plunger displacement. The spring in this position has, therefore, some beneficial effect upon the consumption of power, while serving a much better purpose, in the production of good molds, and although not so important when the air from the jarring cylinder passes through the anvil cylinder, it may be of some value in that case also.

The valve mechanism, and the means by which it is controlled, do not particularly concern the present discussion. It will suffice to say that the machine is started and stopped by an operating lever which controls the admission of air to the automatic mechanism. So long as this lever is held down, the machine will run automatically, and when released, the machine will stop. A latched lever is arranged to adjust the stroke, which can be varied while the machine is running. A safety stop is also provided to limit the table movement through the action of the main valve attached to the plunger base. When pressure is admitted to the jarring cylinder, the anvil cylinder opens to exhaust. When in action, it descends while the table is rising and then rises to meet the falling table.

The figure represents the design of a machine now being built for a large foundry to handle half-molds weighing 25 tons. The table is a steel casting 8 × 12 ft., with lifting cylinder 3 ft. in diameter, and the plunger base forming the anvil is a solid iron casting weighing 65,000 lbs. This is carried upon 22 steel springs, designed to compress 8 ins. under the maximum load and to develop a working stress of only 60,000 lbs. per sq. in., which is very much less than the usual working stresses on railway car springs and quite within safe limits. The total weight of the machine complete will probably be in excess of 90,000 lbs. This is carried in a concrete pit designed simply to protect the machine and to support the static load on the floor of the pit.

The earthquake from a loaded table weighing 65,000 lbs., dropping 2 to 3 ins. upon an anvil bedded in the ground, can readily be imagined. Not only would it undo the work done by the machine, but a large area of valuable floor space in its vicinity would become useless and office buildings at a considerable distance might vibrate in sympathy. In this instance a comparatively small jarring machine of a well-known type, with anvil mounted on wooden cribbing had caused more or less annoyance to the occupants of office buildings in the neighborhood, and the machine above described was designed to avoid further trouble of this character.

It has been shown that a floating anvil which does not rise to meet the falling table, when equal in weight to the latter, has only one-quarter the efficiency of an anvil founded on rock. The efficiency of such an anvil, when mounted and actuated so as to acquire a momentum equal to that of the falling table at the instant of impact, remains to be determined. Obviously, the anvil will meet the table midway when the latter has fallen half the distance by which they were separated. Its velocity at this point will be $\sqrt{\frac{1}{2}}$ into the velocity of the table falling the whole distance, and the velocity of the anvil will be the same. But, in this case, the velocity of the table is entirely destroyed, while in the previous assumption the change in velocity at the instant of impact was only half the final velocity The relative changes in velocity are, therefore, as $\sqrt{\frac{1}{2}}$ to $\frac{1}{2}$, (0.706 to 0.500) and the ramming effects in the two cases will be to each other as the square of $\sqrt{\frac{1}{2}}$ to the square of $\frac{1}{2}$, or as $\frac{1}{2}$ to $\frac{1}{4}$. Under the assumed conditions the anvil in the shockless machine is therefore twice as efficient as the same anvil cushioned on a wooden crib.

It might be shown still further that the vibratory action which develops equal momentum between the tabie and anvil is more efficient mechanically than any other action which develops unequal momentum. With compressed air as a working fluid, however, it pays to utilize its potential energy in the anvil cylinder rather than throw it away, and a decided gain in effect is realized in this way.

It may also be pointed out, that when the sand is soft the change in the velocity of the table at the instant of impact is greater than it is when rammed, because in the first condition the table movement is arrested before that of the sand, while in the latter condition, both stop together.

The loss of power in cylinder clearances is well known, and the obvious remedy of a short passage from the valve to the cylinder has led to the use of internal valves of more or less ingenuity and efficiency; but experience in machine design clearly points to the futility of attempting to embody all advantages or completely eliminate all disadvantages in any construction. The best machine for any purpose is the best compromise that can be made between conflicting advantages. Rather than save air by the use of a valve which is comparatively inaccessible, is it not better to sacrifice a little air for the sake of good construction, and accessibility to all working parts? At the same time, it may be said that the air consumed in the clearance passage to the jarring cylinder is not wholly wasted. It adds materially to the work done by expansion in the jarring cylinder, and again, when discharged into the anvil cylinder it adds to the momentum of the anvil. In addition to the consumption of air for any given stroke, it must not be forgotten that the blow struck in the shockless machine is twice as effective as the blow for the same expenditure of power in the usual type of jarring machine.

USE IN HIGH BUILDINGS.—Attention should also be called to the possibility of installing a machine of the shockless type on the upper floors of high buildings, where many foundries are now being located. The action of the machine is entirely free from jar except where it is wanted, on the work, and the pulsating variation in floor load while running is no greater than is usually experienced in the operation of power squeezers. A number of these machines are now under construction for installation on upper floors, and in this connection it may be of interest to note that the original experimental machine of this design was set up on floor beams over a pit and operated without any vibration appreciable to a man standing on the beams while ramming up a half mold weighing about 1,000 lbs. In this case the weight of the machine was about 6,000 lbs., and a stroke of 4 ins. was employed. As the movement of the anvil was about 1 in., it met the table when it had fallen about 3 ins. The variation in the load in the floor beams was about 10% of the static load carried, or between 600 and 700 lbs. This variation, however, was gradual, the anvil rising and falling with the movement of the table. When impact occurred, the load on the floor beams simply ceased to decrease, and began again to increase without transmitting to the floor beams any part of the shock of impact, which was confined exclusively to the jarring table and its plunger base.

A HIGH RECORD IN RIVETING is reported by the Chester B. Albree Iron Works Co., of Pittsburg, in a recent letter. In 10 hrs. 12,000 rivets of ¾-in. diameter were driven. A portable jaw riveter hung from an overhead runway was used in this work, and the operator was a man specially expert in swinging the machine rapidly from one rivet to the next. This was on very straight work, where an average of 3,000 to 4,000 rivets per day might be expected in good regular practice.

Cooling-Water Intakes from the Mississippi River for Two Power Stations.*

By JOHN HUNTER,† M. Am. Soc. M. E.

This paper is a description of the condenser supply systems of the two power stations of the Union Electric Light & Power Co., situated on the west bank of the Mississippi River at St. Louis. These stations are known respectively as the Ashley St. and Lewis St. Stations. The former has a capacity of 50,000 KW., 38,000 in steam-turbine units and 12,000 in engine-driven units. The second station has generating equipment of 7,500-KW. capacity, 6,000 in steam-turbine units and 1,500 in engine-driven units. The primary reason for locating these power stations on the river bank was to have an abundance of condenser water available at the minimum cost. The two systems to be described herein are especially worth study because of their location and the source from which the water is taken. The Mississippi River, in its muddy water, carries all manner of refuse and it varies in stage from 2 ft. below zero to 38 ft. above. This river is no respecter of seasons, and any time may find it at any stage, from the lowest to the highest.

ASHLEY STREET STATION.—This station is so situated that its east wall is directly at the water's edge, and the problem presented, in providing an intake for its circulating system, was to have one through which water could be taken at all stages of the river, and which could be constructed at a cost commensurate with the size of the station and the work to be performed.

The design of the building structure provided for a sea-wall running parallel to the east wall of the boiler room, the boiler room being on the east side of the building and the engine room on the west side, and extending throughout the length of the building. This sea-wall is on a line with the river shore and is surrounded by water, except at very low stages of the river. It presented a very desirable location for an intake, as this could be built in and made a part of the wall, without requiring separate and additional construction; the only difficulty being to get it placed low enough to insure a flow of sufficient water at all times. It is at the northeast corner of this sea-wall that the intake is located, and it consists of two wells adjacent to each other, the general arrangement and construction being shown in Fig. 1. Each well is an open section in the wall 6 ft. wide × 7 ft. high, the north well being 20 ft. long and the south 14½ ft. long. The openings to the river are through gateways 4 ft. wide × 7 ft. high. The floor of each well is 58 ft. below the top of the sea-wall, and the wells can be approached from the top through metal shafts 3 × 5 ft. in section.

All elevations are referred to a datum point arbitrarily taken at 100 ft. below the city directrix, which is a station point for all local measurements, having an elevation 412.73 ft. above the sea-sevel and fixed by a mark on a curb-stone in Market St.

What is known as the zero stage of the river was a low-water reading made in 1863 which showed an elevation of 33.71 ft. below the city directrix, and is the point on which all river-stage readings are based. This elevation referred to the datum point for Ashley St. Station is 66.3 ft., which reading is the basis for all river-stage measurements in connection with the work about this station. The floor of the intake wells is 9.26 ft. below the zero stage of the river; the openings of the circulating suction pipes in the intake wells have an elevation of 5.27 ft. below the zero stage of the river, and are the lowest possible point at which water can be taken.

In addition to the opening to the wells, already referred to, there are two other gateways of the same size 20 ft. higher up on the wall, which feed the wells through the metal shafts and were intended to be used for high stages of the river. The gateways are protected on the outside by bars of 6-in. I-beams, concreted on both sides between the flanges, the ends imbedded in the face of the well on 7-in. centers with the flange of the beams facing out. These are a guard against any large substance that might be drawn in from the river. Next to the bars are heavy cast-iron gates, operated by 2-in. square rods extending to the top of the wall, which are for closing the gateways in case it is necessary to shut off the water and get into the wells.

As a protection against small refuse in the water, and there is an abundance of it, there are, on the inside of each lower opening, two wire screens of 1-in. mesh. These screens are hoisted to the surface for cleaning, one screen always being in position. Several hundred yards north of the power station is a city dump where the refuse from stables, produce commission houses, etc., is dumped into the river, and much of this is drawn into the intake, lodges on the screens and makes it necessary at times to clean them very frequently. This refuse passing through the pumps would soon plug up the condenser tubes, and while the mesh of the screens is not small enough to stop everything, yet they are very

*From a paper before the convention of the National Electric Light Association, St. Louis, May 23-27, 1910.

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effective in minimizing the trouble we would have if the refuse had a free passageway to the pumps. The hoisting of the screens is done by a wire rope operated by counter-weights and an electric motor driving a hoisting sheave through a worm-gear and clutch.

The suction pipes to the pumps are five in number, each 30 ins. in diameter, three entering the north well and two the south, in the manner shown on Fig. 1. The lowest stage of the river of which there is any record, was —2.6 ft. on Jan. 2, 1900, and the lowest stage in our experience was on Jan. 12, 1909, when the point reached was —1.6 ft.

The river along the sea-wall has filled in considerably, and at a stage of 2 ft. above the shore extends about 50 ft. out from the wall. A small channel was left to the intake openings, but for the lower stages of river the passage was found not large enough for flow of sufficient water, and it was necessary to dredge in front of the intake out into deep water. This was done in October, 1908, and we now have a clear channel, 14 ft. below the zero stage of the river, extending 60 ft. out into deep water, there being a deep pool in front of the station, varying in width from 25 ft., at the wall, to 60 ft. at the outer end. This provides a large open course for the flow of water even at the lowest stages known. The channel is extremely valuable in the winter season when the river is full of ice. Shore ice tends to ground and thus to shut off the water, but, with the channel so deep, the ice forms a solid bridge across, leaving a free open passageway. Soundings are frequently made directly in front of the intake during low-water periods so as to insure against any possible obstruction to the flow of water.

The sea-wall is built of concrete reinforced with steel frames tied to the main building wall. This work was done back of a steel cofferdam, but, on account of the varying stage of the river, it was impossible to keep the dam tight, and that portion of the wall containing the intake wells was constructed by means of a caisson, the well chambers being constructed within the caisson. While the construction of these wells was incidental with the construction of the sea-wall, an independent structure would have had to be built equally as substantial to withstand high-water levels and provide adequate means for handling screens, so that the cost for an independent structure would probably have been more than for this portion of the wall.

The intake was designed to provide condenser water for an ultimate station load of 35,000 KW., and this condition was fulfilled very easily. Since the building of the station, many improvements have been effected and with the generally increased efficiency the intake will safely pass water for twice this capacity. The five 30-in. suction pipes lead to a common suction header, to which the circulating pumps are connected. There are five engine-driven, centrifugal pumps, two with 45-in. discharge and three with 30-in. discharge, having a maximum pumping capacity of 165,000,000 gals. per day. The well chambers have no capacity whatever, and they simply serve as a junction box between the intake gateways and the suction pipes of the pumps.

Readings are frequently made of the water level in the wells and of the river, the difference showing the head of flow through the gates. This head is an indication of the condition of the bars on the outside of the gateways, which become clogged with refuse. For cleaning the bars, a by-pass pipe from the main discharge header of the circulating system opens into the wells. When the head of flow indicates a choking of the bars of either well the suction valves to this well are closed and the by-pass valve opened, allowing the discharge water to flow outward through the gate, washing away whatever is in front of the bars. This scheme for cleaning the gates is very effective, as indicated by the working level of the water in the well after the flushing has been done. These by-pass connections are also used in the winter time to clear the wells from ice, the warm discharge water being allowed to pass into the wells in just sufficient amount to break down whatever ice forms.

The flow of water through the wells is sufficient to keep them free of all sediment, and on several inspections they were found perfectly clean. While there are two openings to each well, it has been found desirable to use only the bottom opening at all stages of the river, for to allow water to flow through the upper gate reduces the flow through the bottom gate, so that it quickly fills up with silt and sand. As a further protection to the intake from refuse in the water, a wall of interlocking steel piling was constructed around the openings, extending out from the north corner of the fall 15 ft. and then south about 30 ft. so that the water must flow backward into the wells. This wall has added very much to the safe operation of intake, especially during the winter when the river is full of ice.

LEWIS STREET STATION.—An entirely different problem was presented in providing an intake for the Lewis St. Station. This station is located in the city block directly north of that occupied by Ashley St. Station; it sits on the west side of the railroad tracks that run along the levee, and is about 300 ft. from the water's edge. Along the river shore at this point there is an underlying bed of solid limestone, at a depth varying from 10 to 15 ft. below the ground surface at the west building line to from 30 to 40 ft. at the edge of the bank. This station was erected in 1901. The early operation was conducted on a comparatively small scale, and as the requirements for condenser water were not very great an effort was made to reach the river by a surface pipe line. This was not successful, for after being constructed it was displeasing to the harbor authorities and had to be removed. A later effort was made to get a river connection by constructing an underground conduit along the surface of the rock. Considerable time and money were spent on this venture, but the job had to be abandoned on account of the nature of the soil and the various obstructions encountered. It was finally decided that the work that was being avoided, that of tunneling through the solid rock, was the only practical way of getting a proper connection to the river. This was a big undertaking for a plant of this size, but the need of a condensing system was becoming greater every day and the work of driving a tunnel through the solid rock to beneath the river to get a connection for water was undertaken. Surveys were carefully made of the condition of the rock as far out into the river as it was deemed desirable to locate the intake, in order to determine the proper depth for the tunnel. In erecting the station its ultimate capacity had in a measure been predetermined, and the furnishing of ample water for such capacity was the basis for fixing the size of the tunnel and its conduits.

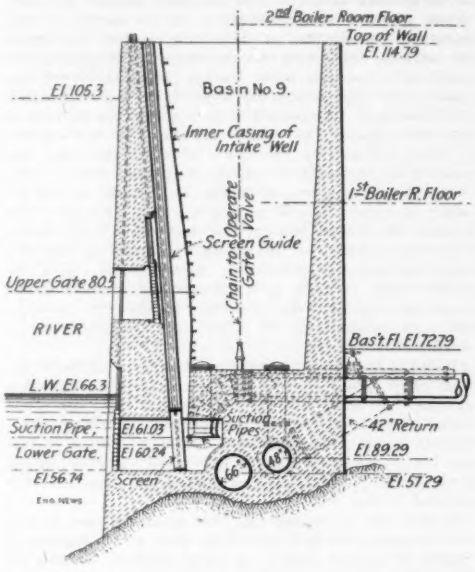


Fig. 1. Intake Wells for Circulating-Water System; Ashley Street Station, Union Electric Light & Power Co., St. Louis.

The construction of the tunnel was started by sinking a shaft through the earth and solid rock at a point about 50 ft. east of the station building, and then excavating through the rock from this point, west toward the station and east to the river. Much care had to be exercised in driving the tunnel toward the river, as deep fissures extended into the rock at several points, and to strike one of these meant to flood the job. Precaution was taken by drilling small test holes 15 to 20 ft. into the rock ahead, and this proved a very valuable safeguard, as the course of the tunnel had to be changed from that previously determined, sloping to a lower elevation so as not to run into open water before the required distance into the river had been reached. The condition governing the distance the intake should extend into the river was the low stage of the river.

The tunnel shaft has a cross section 10 × 10 ft. and it is sunk to a depth of 90 ft. below the ground surface. There are two tunnels to the river, both beginning at the shaft, one extending slightly toward the north, which is for the suction water, the other slightly toward south for the discharge. A single tunnel leads west from the shaft to beneath the station building, connecting with the pump room and containing both the suction and the discharge conduits. Each tunnel has a general cross section 9 × 9 ft. The suction tunnel extends 275 ft. from the shaft, which is 75 ft. beyond the shore line at low water. The discharge tunnel runs 232 ft. out from the shaft. Both take a downward slope, and at the extreme outer ends are 60 ft. apart, as shown in Fig. 2. The top of the north or suction tunnel at its outer end has an elevation of 47.3 ft. below the surface of the river at low water. The rock at this point is 8 ft. thick. There is a layer of loose rock, sand and mud about 19 ft. deep, leaving 20 ft. of open water. The discharge tunnel ends in a big room, which had to be provided for the installation of the large tubes it contains. Its top is 38.3 ft. below low water, with about the same thickness of solid rock and loose rock and sand above as has the north tunnel.

The suction conduit in the north tunnel is 48 ins. in diameter and is constructed of reinforced concrete. The south tunnel has two conduits, one 48 ins. in diameter, of reinforced concrete, similar to that in the north tunnel, and which is the discharge conduit. The other is of 18-in. iron pipe, originally constructed as a temporary suction conduit, has been continued in this service and has since been encased in concrete.

The means of getting water from the river into the suction conduits is through strainer tubes, one end connecting with the conduit, the other extending through

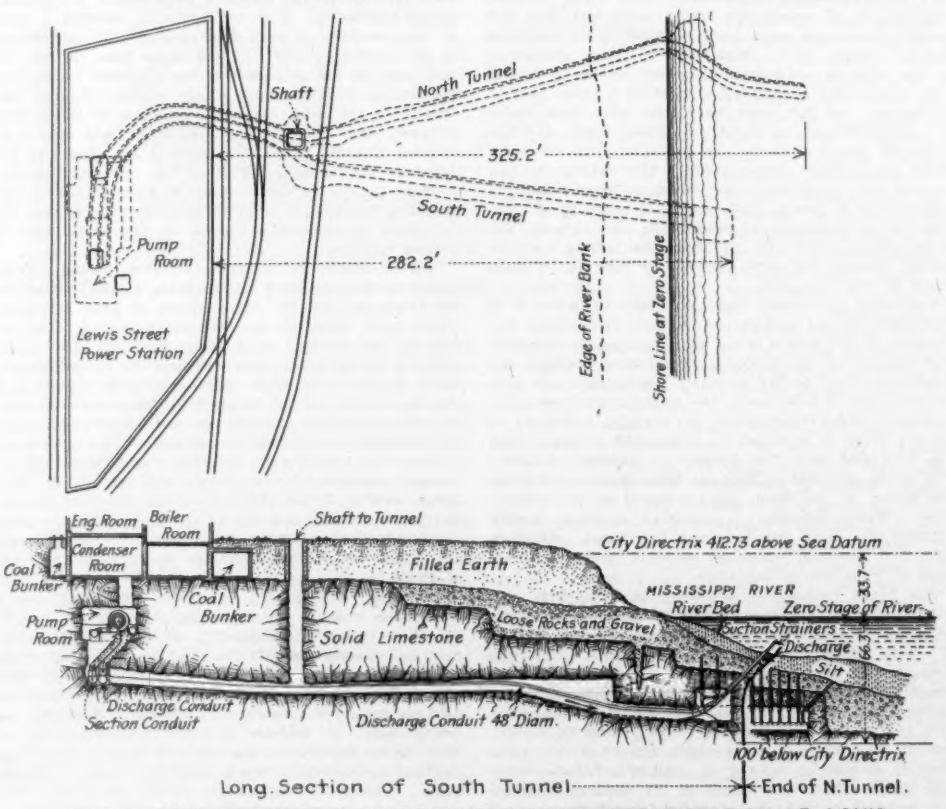


FIG. 2. COOLING-WATER INTAKE TUNNELS; LEWIS STREET STATION, ST. LOUIS.

the solid rock into the sand and mud above. The suction tubes are of 6-in. standard pipe, and that portion extending beyond the face of the solid rock is 8 ft. long and perforated with 7/16-in. holes on 1-in. centers, the outer end being closed. The placing of these tubes was accomplished by drilling 8½-in. holes into the solid rock to a depth of 4 ft. Into these holes pieces of 7-in. pipe, with flange and valve on one end, were inserted and made fast by grouting in with cement. With the 7-in. sleeves and valves securely in place the drilling of the rock was continued to within a fraction of an inch of the surface. The 6-in. strainers were then inserted into the openings and forced through the film of stone left on the surface of the rock and into the gravel, sand and mud above. The strainers were pushed into place by means of pushing rods and a hydraulic jack, and to guard against their being pushed beyond the edge of the solid rock the distance was accurately predetermined and the tubes were left extending 6 ins. within the rock to keep them from washing away. The placing of these strainers was a very delicate part of the work and required considerable precaution, but it was accomplished without an accident of any kind. There are 18 such strainers in the north tunnel and four of them in the south.

The connection between the discharge conduit in the south tunnel and the river was made in practically the same way as that of the suction strainers just referred to, but the discharge tubes are larger and fewer in number and extend further into the river. There are three of these tubes, each 18 ins. in diameter and 27 ft. long, made up in two sections with inside coupling. The placing of such large tubes was a considerably more difficult operation than the placing of the 6-in. strainers, but it was accomplished with as much success. Short holes, 24 ins. in diameter, were first drilled into the solid rock. Into these holes specially constructed cast-iron sleeves, with flange and 20-in. gate valve on one end, were placed and secured with concrete grouting. With the sleeves and valves securely in place the drilling was continued, but in this case light blasts were used for removing the rock. As a further precaution against a flood of water, while pushing the large pipes into the river, a stuffing box was arranged below the valve, so that when the pipes were inserted into the cast-iron tubes they could be carefully packed, and any water breaking through into the drilled holes could not flow back into the tunnel. It took considerable pressure to force the large pipes into place—at times almost equal to the crushing strength of the pipes. They were not pushed as close to the edge of the solid rock as the 6-in. strainers, the inner end of the pipes remaining within the cast-iron sleeve to give them a bearing, and also to make the connections more water-tight, as the holes in the rock through which they passed were not very regular.

A test was made on a section of the 48-in. reinforced-concrete conduits, which test showed they would be perfectly tight up to 50 lbs. pressure and that they would not burst at 150 lbs.

The operation of the system was started by using the temporary 18-in. suction pipe. The three discharge connections to the river had been completed first, and into two of these, strainers made of 14-in. pipe 21 ft. long were inserted, connecting to the temporary suction pipe and extending about 10 ft. into the clear water. The early experience with these strainers was very discouraging, owing to the immense amount of sand, mud and refuse that came through, and it was on this account that the regular intake strainers were made of smaller diameter and shorter so as not to extend into the open water, the idea being that the water filtering through the mud and sand would be much clearer and free from refuse. After the installation of the permanent suction tubes one of the larger strainers was abandoned, but the other was kept in service, as the smaller tubes did not admit the quantity of water that was anticipated.

It was found, after the system was in operation for a short time, that the flow of water decreased very rapidly, caused by mud and refuse clogging up the strainers. To overcome this, air connections were run to the strainers for blowing them out, the connection to the 14-in. strainer being fitted up with an electrically-operated valve controlled from the circulating-pump room. The small strainers are blown out singly by hand operation. To flush out the big strainer the circulating pump is slowed down, thus allowing the water to flow back, and the air valve opened at the same time, allowing the air to blow through the strainer for a few seconds. The scheme works very successfully, and keeps the strainers from choking up.

As this intake system is now being operated, water is received in the 48-in. suction conduit in the north tunnel, through 18 6-in. strainers, and in the 18-in. suction conduit in the south tunnel, through one 14-in strainer and four 6-in. strainers. The discharge of the system is through the 48-in. conduit in the south tunnel, which is connected to the river through an 18-in. tube. The system, including all excavation, conduit and pipe work and all expense in connection therewith, was completed at a cost of $80,000.

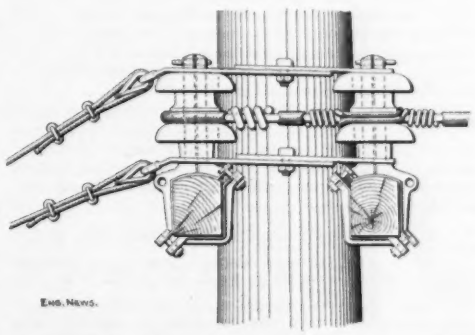
New Ideas in Electrical Distribution Methods.*

By S. B. WAY,† Assoc. Am. Inst. E. E.

The electric distribution systems in St. Louis and vicinity, it is believed, offer some new ideas in the construction and operation of underground and overhead lines.

CONDUITS.—A good underground conduit system for the distribution of light and power requires a structure built from cheap, strong, easily obtained, fireproof and non-conducting material, by a method which will permit easy and perfect inspection of the ducts and structure during construction and give the greatest assurance against faulty work. The ducts when finished should be smooth, as nearly straight as possible, sealed from end to end, and free from offsets, joints, obstructions and water-pockets.

To meet the requirements as to material, concrete seems most available. Some 200,000 ft. of conduit duct, constructed entirely of concrete, without the use of any pipe or tube, is now in use in St. Louis; and the methods employed in its construction are thought to meet the required conditions. In constructing this conduit, a trench of the required width and depth is excavated in the usual manner. The trench serves as the form for the bottom and sides of the concrete structure. In the bottom of the trench concrete mold supports are set and leveled at intervals of 16 ft. U-shaped wooden forms,



Clamp Pins Used With Pin Braces at a Dead Ended Line.

(Union Electric Light & Power Co., St. Louis.)

or duct molds, 16 ft. long, are then laid in the concrete supports, being thus automatically alined, after which concrete is dumped into the trench, worked around, and struck off even with the tops of the molds. The concrete is then allowed to take its initial set, which usually requires three or four hours, after which the molds are removed by simply lifting them out vertically by means of iron hooks. After the removal of the molds, the trench contains only a layer of concrete, in which have been formed longitudinal U-shaped grooves. These grooves are turned into closed ducts by covering them with previously formed, thin, concrete slabs or plates of required width. The joints between adjacent plates and between the plates and the concrete layer containing the grooves are cemented, and the operation above described is repeated for the next tier of ducts. The conduit is finished with a final layer of concrete to give protection against future excavators.

Where it is desired to provide small hand-holes, or service-connection boxes in the conduit between manholes, the concrete is stopped off around the duct-molds at the desired locations, leaving rectangular openings in the conduit structure which serve as hand-holes, giving access to the cables for connections. The concrete hand-holes are thus produced at no additional expense. They may be closed by a cover immediately on top of the concrete structure, or an iron frame projecting up to the pavement level and supplied with a street cover may be used. The buried cover is much cheaper, and has the advantage of requiring no maintenance. By the use of buried covers, on account of their cheapness, service boxes may be spaced so as to offer the same facilities for shortening service connections as are obtained with the Edison tube system.

For average duct sections, the concrete required per duct foot is about the same as with other systems of construction. The cost of laying the molds and of forming and laying the mold supports and concrete slabs is offset in tile construction by the cost of handling and laying the tile. The saving in the cost of construction is therefore approximately equivalent to the value of the tile delivered in the street.

Cables draw into concrete ducts with about the same strain as is required with ducts of other types, and do not show any material scoring, but rather have the appearance of having been sand-papered. Heavy cables in single pulls of 525 ft. have been drawn into concrete ducts without difficulty.

The advantages of this style of conduit construction are low first cost; smooth, straight, well-drained ducts free from joints, blisters and sharp projections; great fire-resisting capacity and adequate protection of working cables from each other. The one objectionable feature in concrete construction is that a street must remain open a longer time where a conduit of more than one tier of ducts is laid. This, however, generally amounts to but one day, as compared with the most rapid methods of laying pipe systems.

CABLE PROTECTION.—Portland-cement mortar being strong, cheap, and possessing excellent fire-resisting qualities, makes an ideal covering for cables in all exposed locations—such as manholes, around switchboards, and in cable runs in stations. The difficulty in making use of it for this purpose arises from its lack of adhesive qualities when first applied. This difficulty is overcome by first wrapping the cable to be covered with cheap rope or cordage, applied spirally with a pitch of about ¾-in. The cement mortar is then most conveniently applied by hand and finished with a quarter-round trowel to a thickness of about ½-in. A rubber glove will be found useful in this connection, as raw cement is hard on the hands. If the cable to be covered happens to be in a warm, dry place, the cement must be kept moist during the first two or three days after application, otherwise it will become very brittle and chalky.

Cables properly covered with cement not only present a neat appearance but are largely protected from mechanical injury, and are furnished with the best fire-resisting cover which it is practicable to apply. Several instances have shown cement covering for cables to be exceedingly valuable in preventing interruption to important service where the cables passed through manhole or other fires. In all these cases cables so covered carried load through fires which would otherwise have destroyed them. Although the lead sheath inside of the covering is frequently melted, the cement remains intact, protecting the insulation and permitting permanent repairs to be made at a convenient time.

OVERHEAD CONSTRUCTION.—The general trend is away from old methods in overhead distribution. It is no longer fashionable to attempt to give good service from lines loosely strung on poles, standing at all sorts of angles and hung on the arms at any point where there happens to be an empty pin. It is important that good materials be selected, and it is absolutely essential, after the materials are in hand, to use in connection with their application methods that will give the greatest possible assurance that the wires will remain well insulated and in proper position. This is not easy to accomplish, in view of the many opposing forces and conditions. Poles pull out of position or rot off at the ground line; crossarms split, rot and break; pins decay and break; insulators and guys fail; and the list of ills could be lengthened materially. A few of these have been greatly mitigated by methods which have been adopted as standard in St. Louis.

Pole settings are made to the usual standard depth of about one-seventh of the length of the pole. To arrest ground-line decay, and at the same time to provide a perfectly solid filling between the pole and the upper part of the excavation, the last 20 ins. of the hole are filled in with well-tamped concrete, finished at the top with the surface raised above the ground and sloping away from the pole, forming an effectual watershed. Provided the lower part of the pole is properly tamped, such a setting is practically as good as an all-concrete setting and is much less costly.

Crossarms are of clear, Western fir, and are not bored for pins or brace-bolts. The arms are well seasoned, are painted by dipping before use, and are attached to the pole by means of a galvanized through-bolt provided with 2-in. square washers under head and nut. Extra heavy galvanized braces, ⅝ × 1½ × 25 ins. are attached to the pole by means of a lag screw and to the arm by means of a clamp (it having been observed that arms frequently break at the point where brace bolts pass through them). The pins and brackets are attached to the arms by means of clamps, which are so arranged as to clamp the arm uniformly on all sides with but two adjustments. The design of the clamp and its application to pins and spreaders are shown in the accompanying figure.

The benefits from using the clamps for making attachments to the arms are manifold. The weakening of the arm by boring holes for bolts and pins and the splitting of the arm by driving tight-fitting pins is avoided. Chances for moisture to collect and induce decay are lessened. By keeping the fibers of the wood bound together, cracking or checking of the timber due to natural causes or to the strain of the wires on the pins is prevented. Insulator supports, such as pins and brackets, are firmly attached to the arm in such a manner as to absolutely prevent them from being displaced. Clamp pins and brackets have been found very useful on old work in replacing wooden pins which have pulled out

*From a paper read before the convention of the National Electric Light Association at St. Louis, May 23-27, 1910.

†Superintendent, Union Electric Light & Power Co., St. Louis.

or broken off, and brackets which have become detached owing to the rusting off or pulling out of the screws. It often happens that an arm split by natural causes or by strain on the pins can be restored to safe condition by the use of clamp-pins and brackets without the expense and risk incident to changing the arm. Clamp-pins have been used where it is desired to sectionalize a line. In this case use is made of pins having a straight shank, upon which spool-type insulators are mounted. The strain of the line is transmitted by means of adjustable pin-braces placed above and below the insulators, which, at the same time, eliminate the necessity of spacer bolts or blocking and through bolts. The accompanying figure shows use of the same style pin and insulator in ending a line. Should it ever be necessary to replace the arms in either of the above cases, the operation will be relatively simple, inasmuch as it will only be necessary to support the pins and insulators on slings, remove the bolts in the clamps, drop out the old arms, place the new arms in position and replace the clamps, as against the great amount of temporary work, labor and risk involved in such an operation with the usual methods of construction.

In order that all parts of the line may be equally insulated from the poles and crossarms, it has been found desirable to mount all primary fuses, primary switches and primary meter boxes on standard line insulators carried on brackets which are hooked over the crossarm. The cost of the brackets and insulators is trivial, considering the increased factor of safety developed, while the labor of installing is less than that incident to screwing the devices to the arms.

We feel that in the interest of safety to linemen, economy in pole space, and appearance of pole-line construction, the use of reverse, or "buck" arms should be avoided to the greatest possible extent. Service connections and branches can be tapped off mains by the aid of spreader brackets, making use of arms already up and avoiding the use of buck-arms. By using spreaders, arranged to fasten to the arms by means of clamps instead of screws or bolts, labor is saved and all danger of their becoming detached is avoided. The service or branch wires should be carried around the back of the pole wherever possible and the exact spacing should be standardized by the use of pole-back spreaders arranged with a notch to fit over the crossarm through-bolt, automatically locating it. The use of spreaders permits any number of services to be taken from one or both sides of a pole with equal clearances from the line wires, and is of especial value where joint occupancy of poles is prevalent.

Proper and adequate guying is of the utmost importance in keeping overhead lines in safe condition. As the cost of guying is a very considerable item in both construction and maintenance, it is desirable to adopt methods which will add to the life of the guy and decrease the cost of installation. All guys attached to poles carrying high-tension wires are equipped with strain insulators so located as to prevent accidents to persons coming in contact with the guy and to prevent current leaking to a pole or other support from the guy. In making up a guy serving or wrapping should be avoided, as it destroys the galvanizing and affords a good lodging place for moisture. Clamps should invariably be used, and clamps of the right kind afford the cheapest method of fastening the guy.

The tying of line wires to insulators is a detail which is frequently not given sufficient attention. The wire should be attached to the insulator as flexibly as possible, and the insulation on the wire should not be injured by the process of tying. Modifications of the common tie will secure these qualities. At points of especially heavy strain the insulation should be removed and the tires soldered. What is known as the "circle tie" may be seen on the right-hand pin in the accompanying figure. Its distinctive features are its security with greater freedom for the line wire to swing and comparatively loose application for avoiding injury to the insulation.

A line-construction wagon has been equipped with a power wire-pulling device. This apparatus has proven very satisfactory in stringing and taking down considerable length of heavy line. For taking up wire, the ordinary reel is mounted and belted to the motor. In stringing wire, the reel is replaced with a drum, around which the pulling-in rope is given a few turns. Two or more wires are drawn over the arms at the same time. The motor is energized from any convenient trolley or power circuit. The advantages of the device are: better control, no long dragging ropes, fewer new hitches and the elimination of two men.

The city authorities are giving more and more attention to the appearance of structures which they permit upon the streets, and in many cases permits to erect special poles or racks for carrying transformers or transformer banks cannot be obtained. In order to provide three-phase service and to avoid long and expensive secondary connections, three-phase pole-type transformers have been adopted for all alternating-current power services of 20 KW. and larger. Such transformers up to 75 KW. in size are satisfactorily hung on one pole, adding much to the neatness and economy of the construction.

Transmission-Line Crossings Over Railways.*

Accidents and Causes.

The increase in the number of high-tension transmission lines, and the development in the protective regulations enforced by public-service corporations and municipal authorities, have created a demand for special methods of construction. Public-service corporations in general, and the railroads in particular, are yearly incurring greater expense in the attempt to avoid interruptions to service or danger to employees or to the public. The attention now given to the subject is due, in large part, to the presence of occasional lines of relatively high voltage. Such lines are objectionable neighbors, and contact with them is unquestionably dangerous, but the greater percentage of accidents is chargeable to the more numerous low-voltage lines. Any potential over 250 volts, with the currents generally used, may cause painful, and under exceptional conditions, fatal injury. The danger from fire is not confined to any particular voltage and, while an interruption to the service of foreign lines may be guarded against by protective devices, such protection is merely electrical and of no avail against mechanical injury.

It is, therefore, necessary to consider all phases of the question as well as all voltages but, since the probability of danger to life, or property, is mainly confined to the immediate vicinity of the power line and particularly to the space over or under the same, this report will deal with the so-called "crossings," and not with the construction of the power line per se. The crossings of trolley contact wires will not be included, because the conditions governing their construction are radically different and the protective measures possible for transmission lines could not be enforced.†

Before discussing either the responsibility of the transmission company, or the measures calculated to insure a greater degree of safety, the following "accidents" should be noted, although, for any given crossing, some of them would be impossible and others extremely improbable:

1. Injury or death from direct contact with a live wire.
2. Injury or death from indirect contact, i. e., contact with an object, harmless in itself, but which is in contact with a live wire.
3. Fires, caused by either direct or indirect contact.
4. Interference with the operation of signals and, therefore, with the safe and convenient movement of trains.
5. Interruption or interference with the service of telegraph and telephone lines, not included in the above classes.
6. Electrical interference with the proper operation of other power circuits.
7. Mechanical obstruction of tracks by large cables.

(1) Accidents of the first class vary greatly, and the amount of injury depends as much upon the particular circumstances as upon the voltage present. There is danger in any direct contact above certain voltages and prevention is desirable.

(2) Direct contact is usually due to a fallen wire but not necessarily so since the slackening or pulling through of the sag of the power wire may lower it sufficiently to permit contact with those riding on the tops of freight cars or other vehicles. Power lines immediately adjacent to buildings, bridges, or other accessible elevations, are more or less subject to direct contact, through the medium of wires, or other objects, either carelessly or maliciously thrown across the power wires. The most common example of indirect contact is probably that of telegraph or telephone wires falling across, or otherwise brought in contact with, a power line, and the consequent injury of persons who may be at a considerable distance from the point of contact.

(3) In a similar manner, fires may be started, either by the direct contact of the original live wire, or by other circuits with which it comes in contact.

(4) A metallic connection with the running rails, on roads equipped with electrically controlled signals, serves to interrupt the operation of the signals and would seriously interfere with the safe and regular running of trains. The result would very likely be to cause signals to fail in the "clear" position, a condition extremely dangerous to train operation. In addition, should the voltage in contact with the signal apparatus, or its connections, exceed a certain amount, the signal equipment would be materially injured.

(5) Interference with the service of telegraph, telephone, or other power lines, may be caused by inductive currents, if the lines are parallel, although the subject is still open to considerable investigation. In general, the greater the distance between the two lines the less the disturbance. In existing installations, where local conditions precluded the absolute separation of the lines, transposition of the wires, together with other corrective measures, has been reasonably satisfactory in result.

The possible causes of accident may be stated as follows:

(1) Injury to the poles, arms, pins or insulators, by
- (a) Wind storms, particularly in conjunction with snow or sleet.
- (b) Unusual loads imposed upon the structure by falling trees, buildings, etc., either by direct impact or through excessive tension in the wires.
- (c) Derailed railroad or trolley cars or the collision of heavy vehicles.
- (d) Fire, from burning brush, the ignition of a pole or arms in case of fire in an adjoining building, or the collapse of the pole line at the crossing, due to failure from fire in another span.
- (e) Decay or corrosion.
- (f) Lightning.
- (g) Arcs from the power wires.
- (h) Insufficient foundation, due to errors in design or workmanship or to subsequent natural causes.
- (i) Increased tension in the wires, on curves, due to improper stringing, and introducing excessive stresses in the poles.
- (j) Malicious mischief.

(2) Failure of the span wire, by
- (a) Excessive ice and wind loads, causing the wires to break or to slack down.
- (b) Unusual loads, due to falling trees, buildings, etc.
- (c) Melting, or partial burning, of the wires, by adjoining fires.
- (d) Burning of the wires by arcs, due to defective, dirty, or broken insulators.
- (e) Lightning.
- (f) Arcs, due to foreign objects in contact with the wires.
- (g) Arcs, due to the power wires swinging into contact.
- (h) Weak spots, due to initial faults or careless handling.
- (i) Weak joints in the wire.
- (j) Mechanical injury, by linemen placing tie wires, clamps, etc., more particularly as applied to solid, hard-drawn wire.
- (k) Broken tie wires, or other attachments, allowing the power wires to fall from the structure or to fall upon a cross-arm and burn either the arm or the wire.
- (l) Corrosion.
- (m) Excessive heating by heavy currents, with a consequent reduction in the tensile strength of the wires.

The above list embraces practically all the possible causes of accident, and they have been enumerated, in order to more definitely outline the desirable features of good construction. It is hardly possible that any one crossing would be subject to all the above causes of accident, and in justice to existing construction it may be admitted that the number of accidents per mile of line is extremely small. However, the interests of the power company, and of the foreign company, are nearly identical, since each is desirous of avoiding accidents, and the real issue is the cost of protection vs. the degree of safety assured.

Nearly all of the foregoing causes of accident may be very successfully guarded against, in the design, workmanship, and maintenance, and by providing the necessary clearance between the power line and adjoining tracks, buildings, trees, etc. The remainder [(1-f), (1-g), (2-d), (2-f)] are due to lightning and arcing, and while not usually preventable, may be made less destructive by precautionary measures.

The initial expense, which is warranted in any given installation, depends upon the character of the power line, and more than one class of construction may be desirable. Several suggestions have been made as to the proper divisions, and discussion of this feature is especially requested. Merely as suggestions the following are given for consideration:

Construction.

VOLTAGE AND CIRCUIT CLASSIFICATION.—(1) All constant-potential circuits up to and including 6,600 volts and all constant-current circuits not exceeding 10,000 volts. (2) 6,600 to 24,000 volts. A. C. (3) 24,000 to 44,000 volts. A. C. (4) Over 44,000 volts. A. C.

VOLTAGE CLASSIFICATION.—(1) 220 to 5,000 volts. (2) 5,000 volts and over. Attention is called to the fact that voltage may not be the governing feature, as amperage, in some cases, is more important.

CRADLES.—The function of a cradle, net or guard wire, is to prevent contact with a falling power wire, or to prevent a telegraph, telephone or other wire, falling on the power wire. The latest practice in this country is, as nearly as may be possible, so to install the power line that the line wires will not fall. The sums heretofore spent on cradles may more profitably be expended in improving the primary installation. Cradles, to be effective, require a considerable mass of material which, if supported by the power-line poles, introduces a greater burden upon them than that of the power wires. A properly designed cradle should almost enclose the power line, since there is no justification for assuming that a wire will fall vertically and within the confines of a flat net of restricted width. When wires fall under tension, the ends often whip out laterally or curl in a spiral from the effects of the original reeling. To prevent burning by the power wire and to provide an efficient ground, in case the cradle is of the grounded variety, the members of the cradle must have a mass dependent upon the current on the power line.

The second type of cradle mentioned (that enclosing the

*From the Joint Report of the Committee on Overhead Line Construction of the National Electric Light Association and the Committee on Electricity of the American Railway Engineering and Maintenance of Way Association. Presented at the Convention of the National Electric Light Association at St. Louis, May 23-27, 1910.

†The measures recommended by the Railway Signal Association to protect track signals against interference from electric-railway currents were described in Engineering News, Jan.-June, 1907, p. 25.—Ed.]

telegraph or telephone line) is somewhat less objectionable, since it can be made a more effective physical shield, is located upon a lower line, and does not introduce loads upon the power poles. This form of cradle may sometimes be placed under a telegraph or telephone line to prevent the wires of that line from falling upon power wires beneath them, although the location of a telephone or telegraph line above a power line is very undesirable and to be avoided if possible.

The general use of cradles would involve the presence of many unsightly structures over public thoroughfares and railroad rights-of-way, particularly if the types used in Europe, where the cradle has attained its greatest development, are to be followed.

GROUNDING.—In order to prevent the burning of wooden pins and crossarms by arcs from defective insulators, or fallen wires, by causing the circuit breakers to act, some specifications have required that cross-arms should be of metal, or be provided with metallic strips, and that they should be grounded. In other instances, metal grounding arms have been placed below the wires so that a falling wire would come in contact with them. It has also been required that the poles themselves should be grounded, particularly in the case of metal poles. On the other hand, the grounding of wooden cross-arms results in the loss of the insulating value of the wooden arm. In dry weather, a wire falling upon a wooden arm would not necessarily burn either the arm or the wire. A wire falling upon a metal or a grounded arm might be melted and fall from the structure without shutting off the current. The efficiency of a grounded arm, and its practical usefulness, depend upon the voltage, the current, and the circuit breakers.

The construction of high voltage lines and the setting of their circuit breakers is such that the usual types of grounded arms, or grounded poles, when the arms and poles are of metal, would shut off the current without injury to the structure only in case more than one wire of the circuit was affected or the system was grounded. In addition, it is a common practice to "throw-in" the circuit breakers, one or more times, in an attempt to "burn-off" a supposititious foreign object on the line. It is within the experience of many engineers that arcs can persist for a considerable period without entirely throwing out the line.

It has sometimes occurred on high-voltage lines, without an efficient ground, that an arc has been formed enveloping a large portion of the pole top; with the consequent probability of injury to the structure. If it can be shown that for certain currents and voltages, power wires falling upon an ungrounded wooden arm will not so burn the arm as to cause failure of either the arm itself or of the wires, the grounding requirement would not appear necessary. In case the power wire is provided with a secondary attachment to another insulator, a wire would not fall from the structure, though burned at the primary insulator; and the danger of burning would then be confined to the arm itself.

It has been stated that bringing the earth ground up to the pin concentrates at that point lightning, or surge disturbances from whatever cause, and necessitates a higher grade of insulation.

The carrying capacity of the grounding connection should depend upon the nature and capacity of the power line.

It is probable that very different results will be obtained at different voltages, and it seems likely that different requirements will be necessary for different types of transmission line, i. e., that different specifications, or different clauses in the specification, should be used to apply to a high-tension line on steel poles and steel arms from those for lower voltages, wooden poles and wooden arms.

SIZE AND MATERIAL OF WIRES.—The desirable qualities in the power wires, in so far as the crossing construction is concerned, are mechanical strength, ability to resist corrosion or other deterioration, and an electrical capacity sufficient to carry, without injury, the current of the line in question.

Theoretically, the necessary breaking strength of a wire for a given span, will depend entirely upon the sag, since by increasing the sag, the tension in the wire will be reduced approximately in proportion to the sag. Practical considerations, however, indicate a rather indefinite minimum, below which it is undesirable to go. Any surface injury, such as local pitting by arcs and nicks from careless handling, or any weakness in the material, due to errors in manufacture, will have a relatively greater effect upon a small wire than upon a large one. Since insulated wires are used for low voltage lines and the insulation is a protection against mechanical injury, it would appear that the smallest permissible size should apply to such wires and that they may be solid instead of stranded.

INSULATORS.—While there is a great difference of opinion as to the relative merits of various makes and types of insulators, and while any definite requirement would seem improper, the following desirable characteristics may be noted, i. e., a conservative insulating capacity for the line in question, freedom from internal stresses and from injury by the expansion of ice, mechanical strength against temperature changes and external forces, and a smooth exterior surface to assist the cleaning action of rain.

In the case of low-voltage lines, a higher grade of insulator can be installed at little additional expense and since the greater number of accidents originate at the insulators, it would seem economical to require a relatively high-grade insulator for such lines and omit certain other requirements that may be necessary on high-voltage lines where the factor of safety in the insulators is less.

PINS.—On high-voltage lines the insulator pins, at crossings, should be of metal, and there is no apparent reason why any reasonable factor of safety cannot be obtained. There are, however, a large number of low-voltage lines using wooden pins; and the possible decay or burning of such pins and their limited mechanical strength has raised a question as to the limiting conditions under which wooden pins are permissible.

In general, the pins should extend well up into the insulator in order to reduce the mechanical stress upon the material of the insulator. On account of the improbability of frequent painting, metal pins should be double galvanized, or otherwise protected against corrosion.

It may be noted that some of the long pins now in use would, in case of a broken wire, develop a very large torsional effect upon the cross-arm, and an excessive bending stress upon the cross-arms on curves.

TIE WIRES.—The usual function of the wire "pigtails," used to attach the power wires to the insulators, is to prevent falling, rather than to effect dead ending. Assuming the most efficient form of tie attachment, there is some unknown relation between the size and number of turns of the tie wire and the size of the power wire which will be dead ended thereby. Further, the efficiency of a tie wire is almost entirely dependent upon the workmanship, and the linemen should be taught to make this attachment without nicking the power wire.

CLAMPING DEVICES.—The general idea of the clamping devices is (1) to give an efficient insulator and a positive, dead-ending attachment of the wire to the insulator through a device having sufficient mechanical strength to resist the tension of the wire in case the insulator fails; (2) to give a device of sufficient mass to resist burning; (3) to insure that the points of attachment to the power wires are at a sufficient distance from the insulator to minimize the danger from arcs. The attachment should be so designed that it cannot fall free of the pin in case the insulator is shattered; it should not require delicate adjustment, and should be firmly clamped to the wire without injuring the wire in any way.

It has been claimed that a clamp, by restraining the wire and forming a sharp point of bending as the wire sways with the wind, would promote crystallization and cause the wire to fail. Even in view of the voluminous opinions on this point, as applied to trolley-wire ears, it is doubtful whether a clamp with well rounded orifices would introduce any appreciable injury to the line wire. However, it is entirely practicable to design a clamping device which will allow both vertical and horizontal bending at the insulator, rather than at the clamp.

It has been claimed that clamping devices materially reduce the effective arcing distance of the insulators if in the form of caps which envelope the head of the insulators.

INSULATED WIRE.—Since the crossing construction does not contemplate placing any dependence upon the insulating value of the covering of an insulated wire, the insulation should be carefully removed whenever it is necessary to attach clamps, in order that the clamp may be securely tightened. It is probable that thin bushings of soft copper, aluminum, lead, etc., are advisable throughout the clamps, to prevent injury to the surface of the power wire. Similar bushings, or a wrapping of fine wire, may be placed at the insulators and for some distance on either side, to prevent pitting the surface of the power wire in case arcs are formed.

PRESERVATIVE TREATMENT.—Any approved method of preserving wooden arms and poles is desirable in so far as the life of these parts is concerned. It should, however, be noted that the ease of ignition of the arms in case of arcs, and of the poles in case of grass or other fires, may be increased by preservative treatment.

If the crossing poles are upon a public street, the possibility of soiling the clothes of passers-by must be considered.

Wooden poles have somethimes been set in a concrete base in order to prevent decay at the ground line, and while the life of the poles is undoubtedly increased, it would appear better practice to allow the pole to project through the concrete at the butt, so that dry rot may be delayed.

THE UNUSUAL WORK encountered on the Panama Canal necessitated the purchase of some exceptionally heavy narrow gage equipment. The equipment which was purchased is much heavier than ordinarily used on construction work, the cars being 60,000 lbs. capacity, weighing not less than 15,000 lbs., having a 42-in. gage. The contract for this work was awarded to the Orenstein-Arthur Koppel Co., Pittsburg, Pa., the stipulation being that these cars should be delivered before July 15.

Economic Considerations Governing the Selection of Electric Railway Apparatus.*

By F. DARLINGTON,† M. Am. Inst. Elec. E.

There is often great variance of opinion or serious doubt among engineers and railway men as to the relative merits of the three electric railway systems that are more or less in common use. It is the purpose of this paper to discuss the matter briefly from the standpoint of economy of construction and operation. It is not intended to discuss the economical value of electric motive power compared with steam power, except to point out that the high cost of electric equipment is the chief thing that prevents the rapid extension of railway operation by electric power. There is no general rule by which the cost of electrical equipment can be determined, because this cost is affected by such a great variety of conditions.

There are three distinct parts in the equipment required for every electric railway system: (1) the generating plant; (2) the transmission and distribution system, including substations or transformer stations; (3) the electric locomotives and electric cars. Of these, the cost of the power plant and of the motive power apparatus varies with the total amount of power required for train propulsion at times of heavy traffic movements. On the other hand, the cost of the power transmission and distribution system varies with the length of the track equipped, with the maximum total power required and with the maximum power that may be concentrated at any place on the line.

TRANSPORTATION REQUIREMENTS.—Railway service varies according to the requirements of traffic, and the motive power of railways must operate trains of different weights from light single car trains of 25 to 60 tons each, as on interurban electric roads, to heavy freight trains sometimes of 1,000 or 2,000 or more tons each.‡ Increase of train weight tends to reduce operating expenses, and consequently railroad practice is steadily making trains heavier and heavier.

Trains must be operated at varying speeds, since some kinds of traffic demand higher speeds than others, and on every railway there are some places where it is safe and economical to run faster than at other places. Therefore the motive power should be economical at all speeds.

The power per train depends, of course, on the weight and speed of trains, on the grades to be climbed, on the stops and starts required, etc. Since the total power and the tractive effort required vary according as the train is being accelerated, running at maximum speed, climbing a grade or coasting down grade, the power and tractive effort are constantly varying.

Which of the three well-known electric systems (each of which has its ardent and often partisan advocates) is best adapted to meet all of the variable conditions? The systems are: (1) direct current; (2) single-phase; (3) three-phase. The electric motors used in each system are fundamentally different from the motors used in the other two systems, and require a different kind of electric current for their operation. This necessitates for each system different apparatus for the distribution of the electric power.

Power Plants.

The electric power generating stations are usuall steam turbine or hydro-electric plants. Gas engines have not come into extensive use for furnishing power to electric railways. The cost and efficiency of the power plants for the three systems do not differ greatly, for although single-phase generators are more costly than the generators used for the other two systems, the total engine and boiler power usually has to be somewhat greater for direct-current and three-phase than for single-phase operation. This is because the losses are greater in direct-current trolleys or third rails, and in direct-current substations than in single-phase trolleys and transformer stations, and because three-phase motors under ordinary railway conditions make greater fluctuations in the load on the power plant than single-phase and direct-current motors. In spite of the greater capacity in engines and boilers for D. C. operation of railroads than for single phase, it may often occur that the KVA. or apparent electrical output will be greater for single-phase than for direct-current service due to the difference in the power factor of the current supplied.

For three-phase main line railrond electrical operation the power plant will generally be somewhat larger and more costly than for either direct-current or single-phase. This is especially the case where variable heavy grades are encountered or where heavy trains are frequently accelerated, and is caused by the characteristics of three-phase motors which tend to make high peak loads on the power plant when worked at the widely varying tractive efforts and speeds usual in railway work.

Under most conditions, the total of the variations

*Abstract of a paper read before the Western Society of Engineers, Chicago, June 7.

†Westinghouse Electrical & Mfg. Co., Pittsburg, Pa.

‡Not on the same road, of course.—Ed.

described does not cause a large difference in the cost of the power plants for the three systems. Ordinarily the cost of steam turbine plants for railway electrical operation is about 25% to 40% of the total cost of electrical equipment. It more closely approaches the larger proportion of the whole cost when the traffic is dense, requiring a large supply of power per mile of track, or where high-tension single-phase trolleys are used, which by their relatively low cost reduce the total cost of electrical equipment, thereby making the cost of the power plant a larger proportional part of the whole electrification cost.

Power Transmission and Distribution.

The power transmission and distribution system forms the link between the power plant and the electric locomotives or cars. It consists of trolley lines or third rails, feeder cables, track bonding, sub-stations and high-tension transmission lines. The aggregate cost of these items is the largest or at least a very large part of the total cost of electrification for heavy railway operation. Where direct-current is used, the power transmission and distribution apparatus generally costs more than either the power plant or the electric locomotives and motor cars; it is liable to be between 40% and 60% of the total electrification cost, and is especially high where heavy trains are to be operated requiring large units of power distributed over long sections of track. Under these conditions, even where advantage is taken of the most modern improvements (using 1,200-volt direct-current on trolleys or third rails) the cost of direct-current distribution apparatus is still the largest cost item for electrical equipment.

Where single-phase apparatus is used the electric power transmission and distribution system is greatly simplified and cheapened. A single high-tension trolley wire is substituted for the trolley wire (or third rail) and feeder cables of the direct-current system, and static transformer stations are substituted for direct-current substations in which there are both static transformers and rotary converters or motor generators. The single-phase trolley system is equally suitable for light infrequent service and for heavy dense service or for large units of power infrequently operated. The substations are widely separated, and their cost, as well as the cost of the distribution conductors, is much less for single-phase than for direct-current, so that the combined cost of the substations, and transmission and distribution conductors, may be fairly stated under average railway conditions to be about 25 to 60% as costly for single-phase as for direct currents.

Where three-phase apparatus is used, high-tension alternating-current trolleys are employed and three conductors are necessary to carry the current for three-phase motors, so that two separately insulated trolley wires are necessary in conjunction with the track rails.

Three-phase motors can be built for working on higher potentials than can either direct-current motors or single-phase motors as ordinarily used. For this reason the potential employed on three-phase trolley lines is usually applied directly to the motors without intermediate reducing transformers carried on the locomotives or cars. The desirability of working the motors without transformers, combined with the difficulty of separately insulating two trolley conductors for very high potentials, has generally prevented the use of as high potentials on three-phase trolleys as are common on single-phase trolleys. The latter are often built for 11,000 volts potential on the trolley, while according to present practice 3,000 volts is usual and 6,000 volts is high for three-phase trolleys, though in the latter case reducing transformers are generally used on the trains.

Three-phase motors for their successful operation under the varying loads encountered in railway work require more uniform potential supplied to them than is required by either single-phase or direct-current motors, and in order to maintain better potential regulation on the trolley at the relatively low voltages at which three-phase trolleys are generally operated as compared with single-phase trolleys, it is necessary to locate transformer stations closer together on three-phase lines than on single-phase lines. For heavy trains the number of transformer stations will generally be more than double as many, and under certain conditions, three or four times as many for three-phase as for single-phase installations.

There is another thing about three-phase transformer stations for railways that is becoming more important than it was a few years ago when it was not practical to use as high a potential on transmission lines as can be advantageously used to-day. Three-phase transformer stations require either one three-phase transformer or three single-phase transformers. It is much more costly to build one very high voltage three-phase transformer or three single-phase transformers than one single-phase transformer of the same aggregate output. In other words, the cost of transformers per KW. of capacity is very much greater for three small units than for one large unit, especially when they are for very high primary potentials such as 100,000 or 110,000 volts. It is now well established that 110,000 volts or thereabouts will be widely used in large long-distance power transmission schemes, the increase in potential over the practice of a few years ago having been brought about largely by improvements in line insulators, especially of the suspended type.

I cannot state just what the relative cost of three-phase and single-phase power transmission and distribution systems will average for the ordinary requirements of railways, but it is clear that with two trolley wires for the three-phase system instead of one wire as for single-phase, and with transformer stations two or three times as frequent for the three-phase as for the single-phase system, the cost for the three-phase system will be considerably increased, and will probably average somewhere from 30% to 80% more than for single-phase.

Relative Characteristics of Motors.

The different types of motors may be conveniently compared by taking the direct-current motor as the basis of comparison, since it is the oldest and best known in railway work. It should be noted, however, that only within the last few years have direct-current railway motors been commonly built with so-called commutating poles and they are now known as inter-pole motors, and the new construction has greatly improved them. Formerly the capacity of direct-current motors for heavy sudden overloads was limited chiefly by commutation, and the maximum voltage for which they were practically built was somewhere between 600 and 700 volts. The use of interpoles has considerably increased this limit, especially for large motors, and has largely done away with sparking on the commutator and flashing over, so that now overheating is the principal thing that limits the capacity of direct-current motors of the latest design.

Single-phase motors for railway work are very similar in construction and in operating characteristics to direct-current railway motors. They are series wound, variable speed motors, and have compensating windings. Their compensating winding is differently arranged from the inter-pole windings of direct-current motors, but performs a similar function, which is to improve commutation; and at the same time it improves the power factor by reducing the self-induction of the motors. They are generally designed to work with variable voltages up to about 350 volts maximum applied to the motor, and experience has pretty well demonstrated that when everything is considered, 15 cycles or thereabouts is the best current frequency to employ.

High potentials are used on single-phase trolleys and whatever the potential may be, whether 11,000 volts or more or less, the potential is reduced for the motor by transformers carried on the locomotives or motor cars. There is one type of single-phase motor called a "repulsion" motor that is used in Europe to a limited extent. It is practically a motor and transformer combined and is heavier than ordinary single-phase motors, but 11,000 volts, which is a common and economical single-phase trolley voltage, is too high for economy and safety on repulsion motors without separate transformers.

An important difference in operation results from the difference in the motor control apparatus used for direct-current and for single-phase motors. Direct-current railway motors are governed to vary the speed and tractive effort by connecting them in series and in parallel by varying the field strength, and by inserting resistance in the circuits to regulate the flow of the direct-current. Single-phase motors are governed in speed, etc., by applying varying potentials to them from different potential taps on the transformer from which they get their current supply. Thus the transformers serve the double purpose of reducing the potential for the motors and varying it to govern the speed.

Single-phase railway motors are heavier and more costly than direct-current motors of the same capacity. Designers state that the difference is somewhere between 10% and 25% in weight and 25% to 50% in cost in favor of direct-current motors as compared with single-phase motors. The transformers required for single-phase electric locomotives will generally constitute about 5% to 10% of the total locomotive weight, and the motors themselves will generally constitute about one-quarter to one-third of the locomotive weight. Additional weight seldom has to be put into the locomotive frame and running gear to carry the extra weight of the transformers and single-phase motors when compared with direct-current motors, because when the locomotive frame is designed with sufficient strength to withstand the shocks encountered in operation it is strong enough to carry all the load put upon it with single-phase apparatus.

There are so many conditions entering into the design of electric locomotives that it is very difficult to determine an average difference in weight between direct-current and single-phase designs with any reasonable approximation. For one thing, the need for series parallel control with direct current makes it necessary to always use either two or four motors to get an even number for connecting in series, when one or three motors might otherwise be lighter and more convenient, and of course there is no need for series parallel control with single-phase motors. Then again the entire weight of any electric locomotive is sometimes necessary to get sufficient adhesion to the track to prevent slipping the driving wheels. This occurs in many designs of single-phase freight locomotives so that if the weight were not in the mechanism, cast iron or other weights would have to be added to get adhesion.

In locomotive design we might perhaps reasonably say that if single-phase motors are 25% heavier than direct-current or three-phase motors, the additional weight would be 8% of the weight of the locomotive and that this weight and 7% additional for transformers would make single-phase locomotives 15% (more or less) heavier than direct-current locomotives.

As already explained this extra weight will often not be objectionable from an operating point of view for freight locomotives, as it may be necessary to secure adhesion, but extra weight of machinery of course always makes extra construction cost, and it will almost always be objectionable in operation, as well as in first cost, with high-speed passenger locomotives. I want to caution you that 15% is not a uniform factor for difference in weight between direct-current and single-phase locomotives for, under some circumstances, single-phase locomotives may actually be lighter than equivalent direct-current locomotives, or on the other hand under certain circumstances they may be more than 15% heavier than direct-current locomotives.

Proportion of the Cost of Motive Power Equipment to the Cost of Electrification.

It is difficult to give an approximate ratio between the cost of electric locomotives and electric apparatus on motor cars and the whole cost of equipping railways for electrical operation. For complete divisions of 100 miles or more on a single track main line, where the trains are heavy and frequent, the cost of electric locomotives may be 25% to 40% of the total cost of electrification; but where the trains are lighter and less frequent this will be reduced to say 15% to 25% of the total cost. On this basis, if single-phase locomotives cost more than direct-current in proportion to twice the difference of their weights, or say they cost about 30% more, this difference in cost between single-phase and direct-current locomotives will amount to about 4.5% to 12% of the total cost of electrification. But under ordinary conditions this is frequently more than offset by the higher cost of power transmission and distribution by direct currents than by single-phase currents.

On interurban electric roads, operating cars at one hour to half-hour headway, the cost of the motors and electric equipment on the cars for direct-current apparatus may be about 5% to 8% of the total electrification cost, and it is about 25% to 75% greater for single-phase apparatus including transformers, etc. On interurban lines (except where they are very short) the difference in cost between direct-current and single-phase motors is far more than offset by the saving in cost of single-phase power transmission and distribution apparatus, and on long interurban lines the difference is a good many times offset even where 1,200 volts is used for direct-current distribution.

Three-Phase Motors and Their Constant Speed Characteristics.

Three-phase motors, unlike direct-current and single-phase motors, tend to maintain constant speed at all loads. They are light and durable and cheap to build. Their advocates claim that on their continuous rating, they are lighter and cheaper than direct-current motors of the same capacity. I am not certain on this point as regards weight, especially since direct-current motors have been so greatly improved by commutating poles and improved design. Large size three-phase motors have somewhat greater continuous horse-power capacity than direct-current railroad motors of the same outside dimensions, but they are usually heavier than direct motors of the same dimensions. In any event, it is entirely immaterial for railroad work how the two types of motors compare at their continuous rating, because there is very little railroad work in which the motive power is operated at a constant rating or at uniform speed and tractive effort. The important consideration is, which motor is the best, the lightest, and the cheapest for the varying speeds and tractive efforts required in propelling trains.

Simple three phase motors are very inefficient at all speeds but normal constant speed, except where a certain device is employed by which it is possible to operate three phase motors at good efficiency at exactly half normal speed, or by another device at exactly double normal speed. Each of these devices (which are known as cascade connections and pole changing devices) require special appliances, and the use of both on one locomotive or motor car in order to get good efficiency at both half speed and double speed as well as at normal speed would be very troublesome, except possibly for low voltage motors for which transformers would have to be carried on the locomotives. Neither of the devices give good efficiency at intermediate speeds or at starting, and as a consequence these phase motors are not so well adapted as other railroad motors for work requiring frequent starting or frequent variations in tractive effort and speed. Other speed combinations than the above are possible but add still further to the complication.

Reliability of Electric Railway Apparatus.

Experience has established a pretty good degree of reliability for electric motive power. Some doubt has been current regarding the reliability of single phase railroad motors. This should be set at rest by the results accomplished with them.

The largest single phase installation is on the New York terminal of the New York, New Haven & Hartford Ry., where there are 40 or 50 1,000-HP., single-phase locomotives in interchangeable operation between 11,000 volts, 25 cycles, single phase current and 650 volts direct current. This installation is demonstrating a high degree of reliability, not only for the motors, but for the entire electrical plant and equipment. On some days every electric locomotive has been in service, none being in the repair shops. Such a thing would not occur with 40 or more steam locomotives. The number of electric locomotive miles made per motive power delay has averaged, for several months at a time, one failure or delay in 15,000 to 17,000 locomotive miles. This is two or three times as many miles as is averaged per motive power delay with steam locomotives in the same kind of service.

The heavy single-phase freight locomotives in service on the Grand Trunk Ry. in the Port Huron tunnel likewise give very reliable service. Including interurban electric roads there are over 20 single-phase electric systems in operation in America, and over 25 in Europe, and while minor difficulties have been encountered in some places an excellent operating reliability has been demonstrated for single phase apparatus.

There is not so much practical railway experience upon which to base judgment regarding the reliability of three-phase motors, as there is for direct current and single phase motors, but such experience as there is, together with the extensive use of three-phase motors for industrial work, points to an excellent degree of reliability, that is unexcelled in any type of motor.

The wide use of series-wound direct-current motors by railways has thoroughly established their reliability.

As to locomotive maintenance costs, experience has demonstrated that it will average less for well constructed electric locomotives of all types, than for steam locomotives.

Efficiency of Distribution Systems.

Brief mention has already been made of the difference in efficiency between the direct current and alternating current electric power distribution systems.

All moderate and large size direct-current railway systems employ rotary converter or motor generator substations located at frequent intervals along their tracks to change the alternating current from the high tension lines to direct current for the trolley or third rail. The apparatus in direct current substations includes moving machines that are necessarily operated much of the time under light loads; also the drop in the direct current trolleys or third rail at time of heavy loads is large, and the average result is that on direct current systems much electric power is lost between the power-house and the trolley wheels or other collecting devices on the trains.

On many large direct current railways this average loss in power amounts to 40% or 50% more or less, but is seldom as low as 35%. These are average losses and indicate the all-day efficiency of the power transmission and distribution systems, and should not be confused with the loss at times of heavy load, or so-called peak load, on the power-house, which latter loss is the amount by which the maximum power-house output exceeds the sum total of the electric power taken simultaneously by the trains.

With the single-phase and the three-phase systems the loss in electric power transmission and distribution is very much less than with direct current. On the large single phase installation of the New Haven road no transformer stations are used, as the current from the generators is conducted directly to the locomotives. The same thing is true in the single-phase plant of the Grand Trunk Ry. at the Port Huron tunnel. The transmission and distribution losses at these places probably average less than 5% and even where transformer stations are used with single phase apparatus the losses are small, but are somewhat greater than 5%. The above statements about the efficiency of single phase distribution, apply also to three-phase distribution, but in a lesser degree because while both systems employ transformer stations without moving parts, three-phase stations have to be closer together than single-phase stations and consequently the transformer losses are greater in the aggregate.

Efficiency of the Three Types of Motors.

A comparison of the full load efficiency of the three kinds of motors show several per cent., probably 3% to 4%, in favor of direct current and three-phase motors compared with the single phase, and this difference is increased 2% or 3% by the losses in the transformers used with single-phase motors, but this difference is partly, or wholly offset by the superior efficiency of the control of single-phase motors which makes no use of resistances to cut down the current when starting and when running slow, as is done with direct current and three-phase motors. In any event whether or not the lower full load efficiency of single-phase motors and transformers as compared with other motors is entirely offset by difference in the efficiency of control, this difference in efficiency is very small compared with the difference in efficiency of the power transmission and distribution systems which is in favor of the single-phase system as already described.

Direct-Current Sub-Stations.

There is one large item of operating labor and maintenance cost that must not be overlooked and which is necessary where heavy direct currents are used, but that has no counterpart in single-phase and three-phase operation. It is the attendance and repairs of the moving machinery in direct-current substations. This is a heavy expense; and for ordinary conditions will run between $2,000 and $3,000 per substation per year.

Uniform Electric Railway System.

Transportation constantly requires interchange of traffic between railroads, and this makes interchange of appliances and uniformity of systems highly desirable even if not absolutely essential. The use of special appliances to gain a slight advantage in some particular limited case will not be justified in railroad work, if a standard and uniform system can be found that will economically and satisfactorily meet all of the many demands on railroad motive power. A choice between the three existing systems should not be based upon consideration of those parts of the system in which there is no great difference in cost or efficiency or in their practical operation. It has been pointed out that (except in the matter of operating three-phase motors) the difference in these regards between the three systems is not nearly so great in the power-houses, or in the electric motors on the trains, as it is in the apparatus for the transmission and distribution of electric power from the power-house to the trains. For ordinary railroad conditions the transmission and distribution apparatus is the most costly part of railroad electrification and is the part in which there is a vast difference between the different systems.

Direct-Current Turbo-Generators.*

By W. L. WATERS,† M. Am. Inst. E. E.

While large power stations are gradually abandoning the use of direct-current generating apparatus, and generating instead alternating current for distribution to substations, yet the number of small power stations and isolated plants generating direct current is increasing yearly. The advantages of the steam turbine set for such plants are smaller floor space and lower maintenance, due to absence of reciprocating parts. The difficulty in building a small steam-turbine set is to design a direct-current generator which will operate satisfactorily at the high speed required for the economical operation of the turbine.

Direct-current turbo-generators have been built in Europe for the past 15 years, but their design and operation has not until recently been sufficiently satisfactory to recommend them for use under American conditions. The early direct-current turbo-generators were built with smooth-core armature and copper brushes, so that the operation was poor. Recently, however, several European manufacturers have been turning out direct-current turbo-generators in sizes up to 1,250 KW. and 4,000 amps. which have proved much more satisfactory. All these machines operated with metallic brushes and naturally suffered from the handicap of excessive maintenance cost. The result of this has been that European manufacturers are now adapting their machines where possible to operate with carbon brushes. American manufacturers realized early that the direct-current turbo-generator would never be a satisfactory commercial machine until it could be built with carbon brushes. But it is only within the last five years that the skill of designers and manufacturers has been equal to constructing direct-current generators to operate satisfactorily with carbon brushes at speeds materially higher than those of standard belt-driven generators. By careful design with auxiliary commutating poles and by accurate shop-work it has been possible to build motor generators for double the speed which was formerly considered possible, while the development of direct-current generators for coupling to steam turbines has proceeded under the same conditions. It can now be stated confidently that a direct-current turbo-generator has been developed suitable for satisfactory operation with carbon brushes under American conditions. They are now built in sizes from 10 to 300 KW. at 125 volts, and from 50 to 500 KW. at 250 volts. Although 600-volt generators do not seem to be in great demand for this type of unit, yet a number have been in satisfactory operation for some time, notably a 1,000-KW. unit (consisting of two 500-KW. generators coupled to one steam turbine) operating at 1,500 r. p. m., which was installed by the North Shore Ry. Co., California, in 1907.

*From a paper before the convention of the National Electric Light Association at St. Louis, May 23-27, 1910.

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Standard speeds which have been found most suitable for these generators vary from 6,000 r. p. m. for a 10 KW., 125-volt machine to 1,500 r. p. m. for a 500-KW., 250-volt type. All of these machines can be satisfactorily built to operate with commutating poles when carefully designed. Most engineers, however, seem to think that a commutating pole is a universal remedy for all commutating troubles. Experience with direct-current turbo-generators and other high-speed machines has shown that this is very far from being true. The commutating pole must be proportioned as carefully as the other parts of a machine, and it was the neglect of this fact which caused the failure and abandonment of this device when it was first used many years ago.

The two factors which limit the design of direct-current turbo-generators are the commutation and the collection of large currents at high speeds. The commutating difficulties can be satisfactorily met in the generators given in the above list if a properly designed interpole construction is used. For generators of more special or more extreme ratings a complete system of distributed compensating winding in the pole faces should be used.

The limiting speed for which it is possible to build large direct-current turbo-generators is decided by study of the maximum, commutator, peripheral speed, which can be conservatively employed with the particular grade of brushes adopted. The following equation limits the design of the commutator:

Commutator peripheral speed = Circumferential distance between brushes on the commutator × the number of poles × r. p. m.

The minimum distance between brush-arms on the commutator, which can be conservatively allowed for any given voltage, is definitely fixed by the conditions of mechanical clearance necessary for accessibility and to prevent flashing, and also by the space required for the necessary number of commutator segments per pole. The number of poles is decided by the current the machine is to commutate. The maximum commutator peripheral speed is decided by the type and quality of carbon brushes which is adopted, while the revolutions per minute should be fixed by the question of maximum economy for the steam turbine. Thus we have the above equation stating a rigid relation between a number of factors, each one of which is subject to restriction.

As an example of this we can take a 500-KW., 250-volt, direct-current, turbo-generator to operate with a commutator peripheral speed of 5,500 ft. per min. We have 2,000 amperes to commutate, which will require at least four and preferably six poles. The minimum allowable distance between brushes on the commutator of this size and type of machine is about 7 or 8 ins., while it should be preferably 10 or 12 ins., using the more conservative figure we should have a 14-in. diameter commutator at 1,500 r. p. m. for a four-pole machine, or a 21-in. commutator at 1,000 r. p. m. for a six-pole machine. Adopting 7½ ins. distance between brushes we could also operate the six-pole machine at 1,500 r. p. m., using a 14-in. diameter commutator. But deciding on a four-pole machine at 1,500 r. p. m., we must commutate 1,000 amps. per pole, which will require approximately 26 1¼-in. × ¾-in. brushes. Thus we will require a commutator 14 ins. in diameter and approximately 56 ins. long, or two commutators each 14 ins. in diameter and 28 ins. long. This example explains the difficulties in operating large direct-current turbo-generators at high speeds if a conservative design be followed, and explains also why generators of extreme rating, in regard to voltage or current, become so difficult to build.

Flexible metallic brushes will operate whether the commutator runs true or not and, having low-contact resistance, they are suitable for collection of large currents. This explains why they were adopted so universally on the early European machines. If the brushes are not carefully trimmed frequently, the trailing edge of a copper gauze or wire-brush becomes ragged, and when the brush is in such condition a short-circuit or sudden violent change in load is liable to make the machine flash over. A new type of copper-leaf graphite brush has been used recently in Europe with better results, but the operation cannot be considered satisfactory, and the cost is high. Carbon-trailing tips have been used with metallic brushes, but this means a complicated and sensitive brush-gear, which is practically as difficult to manufacture and keep in operative condition as a brush-gear using all-carbon brushes.

The life of metallic brush-gear of all types is extremely short, so that the cost of renewals and the continual trimming which is necessary becomes prohibitive.

It is now apparent that the only satisfactory solution of the commutator problem on a direct-current turbo-generator, for American conditions, is the use of carbon or graphite brushes. It is an open question whether it is better to design these machines to operate with ordinary good quality graphite carbon brushes, or with some special high-grade brush which must be obtained, for example, from Europe.

With carbon brushes a commutator is required which runs absolutely true under all conditions and at all

times. Commutators to carry a large current at high speed are always relatively small in diameter and long. The diameter is fixed by the revolutions per minute and the maximum peripheral speed, which can be satisfactorily operated with the particular grade of carbon used and with the degree of accuracy obtainable in the commutator manufacture. The peripheral speed usually adopted at the present time in America is from 4,500 to 6,000 ft. per min., although peripheral speeds 40% higher than this have been used by European manufacturers with a special grade of brush. With the diameter fixed, the length of the commutator is decided by the questions of temperature rise and correct spacing of the requisite number of brushes. When the length of the commutator would be greater than about 30 ins. it usually becomes advisable to build two commutators of half the length instead of one full length. A difficulty which is experienced with any long commutator, or with two commutators in tandem, is the lack of uniformity in the distribution of current between the different brushes on each brush-arm. It can be avoided only by careful selection of a suitable type of brush-holder carefully fitted with good quality brushes and a suitable arrangement of generator leads.

The standard type adopted for direct-current turbo-generators is a cylindrical commutator of the shrink-ring type. Radial commutators have been used to a certain extent in Europe, with good results, but the inaccessibility of the brushes has prevented their extensive adoption. The only advantage claimed for them is a reduction in over-all length and less trouble due to vibration of the armature caused by lack of balance. This reduction in vibration is due to the fact that the operating surface of the commutator is at right angles to the shaft, and consequently in the same plane as any vibration, instead of being at right angles to such a plane, as is the case with a cylindrical commutator.

The V-ring type of commutator is unsuitable for long-speed commutators of small diameter, as with this construction it is difficult to keep the mechanical stresses within reasonable limits. The advantage of the shrink-ring construction is that the stresses can be directly calculated and arrangements made to take care of them. The shrink-rings are of high-grade steel and are of sufficiently heavy section so that the stresses due to centrifugal action are moderate. They will retain their circular form and prevent any local distortion of the commutator.

The standard cylindrical, shrink-ring type of commutator is, in small sizes, built directly on the shaft, while in large sizes it is built on a bushing. The success or failure of a commutator depends upon extremely accurate shop-work and a design such that the deflections and stresses due to centrifugal action and temperature variation are moderate. The micanite or mica used in the construction, instead of being a heterogeneous combination of mica and shellac, must be built up of carefully gaged and selected mica segments of uniform thickness regularly arranged and cemented together with the minimum amount of shellac. This micanite has to be carefully treated so that it takes its final dimensions before being placed in the commutator. Every element in the commutator, that is, the copper, micanite, bushing and shrink-rings, must be carefully gaged. After the commutator is assembled it must also be carefully seasoned, so that there remains no possibility of distortion or of change in the relative position of segments after the machine is placed in operation.

The mechanical construction of the armature is also of great importance, since it is essential that the balance of the armature should not change after the machine is put in operation. This necessitates that the punchings do not get loose or move on the shaft and that the armature winding does not move under the action of centrifugal forces. The punchings are usually either pressed on the shaft one at a time or built up on a mandril bored out and shrunk on the shaft, no intermediate spider being used on account of the small diameter. Opinion varies as to whether the armature coils are better held in position by wedges or by wire-bands, but the most satisfactory arrangement seems to be the use of bands on the small and wedges on the large armature. The end connections on the armature are probably better held in position by steel wire-bands. Bronze shrink-rings have been used for this purpose, but there is danger that they may get loose and change the balance of the armature, as it is very difficult to fix them securely. The question of insulation of the armature winding is extremely important. The insulation on the armature coils must be carefully baked and pressed, so that there will be practically no shrinkage and consequent movement of the coils. The armature winding is exposed to carbon and copper dust from the commutator, and the collection of dirt on such a high-speed armature is also very much greater than on the corresponding low-speed. On account of this it is necessary to be extremely careful in insulating all bare metal on the armature, so that there will be no danger of "flashing over" across dirty surfaces to the grounded parts.

The question of vibration is one of the most serious difficulties to be considered. It is difficult to determine the critical speed of a direct-current, turbo-generator armature; but it is extremely important that this speed of the generator when coupled to the steam turbine shall not be close to the normal running speed. This usually means that the armature must be designed with the maximum possible diameter of shaft, and it is generally necessary to sacrifice the advantage of low-commutator peripheral speed to enable a sufficiently stiff shaft to be used. The question of permanency of balance is equally important, and this requires that there be no relative movement of the component parts of the armature, and also that the shaft neither spring nor deflect under the influence of the temperature variations obtained. Direct-current turbo-generators as built a few years ago would operate perfectly on test when first built but, after running six months, mechanical vibration and deterioration of commutator were likely to be so great that they could no longer be considered commercial.

One of the most satisfactory constructions for small units is a two-bearing set, the turbine wheel being overhung and the two bearings self-alining. This construction obviates any trouble due to lack of alinement. With larger units, however, it is no longer suitable on account of the axial space required by the turbine, and a three or four bearing set with a coupling becomes necessary. Such sets again require careful alinement and careful fitting of the coupling, otherwise there will be trouble with vibration. Oil ring lubrication is effective in the smaller sizes, but forced-flow lubrication is usually required above 100 KW., if the temperature of the bearing is to be kept within reasonable limits and if the operation is to be reliable.

Foreign practice is usually to enclose completely all the armature, except the commutator, and to supply cooling air from a special duct. Here, we do not consider this advisable because of difficulty of access. The usual practice on small machines is to employ a semi-enclosed construction with natural cooling. On large machines, however, as the noise is appreciably more than in corresponding low-speed machines, it may ultimately be found advisable to adopt a more enclosed construction.

At the present time the direct-current turbo-generator can hardly be considered commercial above 500 KW. at 250 volts, and the probability is that in larger sizes it will be necessary to use an alternating-current turbo-generator and rotary converter as a substitute. This substitute may, however, be only temporary in the 750-KW. and possibly the 1,000-KW. sizes. Considerably larger sizes are at present in use in Europe, but it should be remembered that operating conditions there are by no means as severe as here, so that machines which would operate satisfactorily there might fail here.

Report of the Committee on Advertising to the National Association of Manufacturers.*

It is thought best to reproduce the resolutions under which this committee was formed:

"Resolved, That the National Association of Manufacturers advocates the principle that advertising space in periodical publications should be bought and sold like any other commodity, as an exact quantity, measured by circulation that is clearly established and guaranteed.

"Resolved, That only by furnishing in this manner such reasonable and proper proof of the value of the wares which they offer for sale can publishers expect to command the entire confidence of members of this Association.

"Resolved, That there be appointed a Committee on Business Publicity, to consider, in the interest of the advertising members of the Association, all questions of commercial principle arising between advertising members and publishers."

It is generally admitted without argument that a publisher who sells space at so much per inch per thousand copies and overstates his circulation thereby secures money under false pretenses. The principle is exactly the same as if a farmer agreed to sell 1,000 acres of land at $100 an acre and actually delivered only 500 acres, but refused to allow the tract of land to be measured, and by that means led the purchaser to believe that he received 1,000 acres at $100 an acre, whereas he only received 500 acres, but by reason of the fraud was induced to pay double price. Thus far the principle seems to be well enough established.

It is to the credit of hundreds of publishers that they have submitted to examination of their circulation books and this has best been conducted by the Association of American Advertisers, the membership fee in which is $150 a year, an insignificant sum compared with the benefit derived. It is plain that this sum of money can be saved several times over in one single instance when the facts are brought out as contrasted with the payments made upon misstatement.

The general condition of affairs regarding honesty in publishers' statements has very greatly improved, and there are many publishers now who openly advocate and insist upon accurate circulation statements; nevertheless it is true there is still much iniquity in this matter.

Your committee recommends membership in the Association of American Advertisers, and also offers for consideration of the Association the following:

It has been found necessary in the practice of the Post Office Department to make an official investigation of the circulation of newspapers and periodicals in order to determine the right of the publishers to the second-class mail privilege. Publishers' statements of circulation, even when sworn to, were not considered sufficiently accurate for the Post Office Department.

It is a widely known fact that many fraudulent statements of circulation are supplied to merchants and others who purchase space in papers and magazines. Such statements are at variance with the findings of the Government officials. Money extracted from citizens under such false pretenses is stolen and the perpetrators should be adequately punished. Under the present practice of the Post Office Department the result of investigations of the circulation of printed mediums is withheld from the public for reasons not well understood. By this procedure the Post Office Department becomes an aid to, and defender of, fraud. Various members of this Association have been defrauded by false circulation reports and the means for detecting the frauds are withheld by the Post Office Department.

This Association respectfully requests the Postmaster General to publish 100,000 copies annually of the findings of the inspectors of publications.

Respectfully submitted,

C. W. Post, Chairman; L. S. Dow, E. C. Shaw, Committee.

*Presented at the 15th Annual Convention at New York City, May 17, 1910.

The Accident Relief Plans of Subsidiary Companies of the United States Steel Corporation.

An accident relief plan has been placed on trial for one year by the Universal Portland Cement Co., of Chicago, in its plants at Chicago and Pittsburg. If this plan is successful, it is expected that a similar plan will be put into operation for succeeding years. It is the expressed intention of the company to make such relief, as proposed, immediately available to every employee injured and to the family of every employee killed in the work of the company, without the intervention of attorneys. The entire sum of money that may be required will be furnished by the company without contributions from employees.

The privileges take effect as soon as an employee enters the company's service and terminate when he leaves such service, but no relief will be paid for the first ten days of disablement nor for more than 52 weeks. The disablement must be such that the employee is unable to follow his usual or other occupation. No relief will be paid for injuries or death caused or contributed to by intoxication, use of narcotics, or by illegal and immoral acts.

For temporary disablement, single men, in the company's service five years or less, will receive 35% of their daily wage. For each additional year of service 2% is to be added, but single men are to receive no more than $1.50 per day. Married men will receive 50 and 52% of their wage, under similar conditions, and 5% additional for each child under 16 years of age, but no more than $2 per day will be paid.

For permanent disablement, the relief will depend on the extent to which the injury renders it difficult to obtain employment. The specific amounts will be left largely to the discretion of the relief manager, but in general the sums will be in accordance with the following schedule: (1) for loss of a hand, twelve months' wages; (2) for loss of an arm, 18 months' wages; (3) for loss of a foot, nine months' wages; (4) for loss of a leg, twelve months' wages; (5) for loss of one eye, six months' wages.

In case of death, the company will pay funeral expenses, not to exceed $100. Where widows, or children under 16 years old, are left the relief sums will be equal to 18 months' wages of the employee killed, if he has been employed for five years or less. For each additional year of service 3% will be added and for each child, under 16 years, 10%.

This plan corresponds to that tentatively adopted by the subsidiary companies of the United States Steel Corporation.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

229 BROADWAY, NEW YORK

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BOSTON: 43 Tremont Street
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
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Entered at the New York Post-Office as Second-Class Matter.

We have shown on the first page of this issue the design of Mr. H. Van Buren Magonigle for a memorial watergate to be erected on the bank of the Hudson at Riverside Drive, New York City. This design has been awarded first prize in a competition held under the auspices of the Robert Fulton Memorial Association. It now remains for this association to secure the $3,000,000 needed for the proposed construction.

We have already raised the question (Engineering News, Feb. 24) as to why such a gateway, through which the guests of the nation and the city would enter, should be the memorial of a single great man when it might commemorate a line of pioneer inventors of which this one man was the last and most successful. We see no reason why it should minimize our regard for Robert Fulton to make this beautiful gateway a memorial also to those men who made some definite contribution to steam navigation and indeed who paved the way for Fulton's commercial success. We believe that the names of Hulls, Rumsey, Fitch, Morey, Symington, Evans and Stevens, appropriately emblazoned on these pavilions, would but increase the appropriateness of the surroundings for Fulton's tomb.

A change in the plans of the Fulton Memorial Association, to make possible this tardy recognition of the work of Fulton's predecessors and contemporaries, should facilitate the raising of funds by popular subscriptions. Moreover, even when the funds are in hand the plans must be approved by the Art Commission of the City of New York and that body is sure to recognize public sentiment bearing on the historical requirements of the proposed memorial.

An unusually interesting sewage disposal proposition has been submitted to the New York State Department of Health by the city of Rochester, N. Y. The plans for which approval is sought contemplate the diversion of sewage from the Genesee River through a few miles of trunk sewer leading to Lake Ontario, with rough screening, brief sedimentation, fine screening and ultimate discharge into the lake through 7,000 ft. of submerged pipe terminating at a point 50 ft. below the surface.

The particular interest attached to this scheme is not so much the proposition itself as the careful detailed studies on which are based the conclusions to recommend disposal by dilution, with only a minimum of treatment, instead of some more or less elaborate plan of purification. These studies were made by Mr. Emil Kuichling, M. Am. Soc. C. E., of New York City, and embodied in a report made early in 1907. Mr. Kuichling's report was gone over in detail by Messrs. G. H. Benzenberg and Rudolph Hering, M.'s Am. Soc. C. E., and its conclusions were approved by them. We understand the recommended plan meets with the approval of Mr. Edwin P. Fisher, M. Am. Soc. C. E., City Engineer of Rochester. Quite recently Mr. Kuichling has gotten out a supplementary report, which is a most admirable brief review of the present status of sewage purification, with particular reference to conditions at Rochester. We commend this particular report to all who are interested in the general subject of sewage treatment.

In view of the very thorough manner in which Mr. Kuichling has dealt with the sanitary phases of the Rochester sewage disposal problem and the approval of his plan by such eminent sanitary engineers as Messrs. Hering and Benzenberg, it is amusing to see one of the daily papers of Rochester arguing, in effect, that Mr. Kuichling may be a very competent civil engineer but that the problem ought to be submitted to a sanitary engineer. Several Rochester papers, it may be added, appear to be strongly opposed to the discharge of sewage into Lake Ontario without extensive purification. If this opposition be genuine (which we have no reason to doubt) it would seem that their editorial writers can hardly have given a careful reading to Mr. Kuichling's very clear report on both the capacity of the lake to receive the sewage as proposed and the relative costs and advantages of this and the other plans. Moreover, a careful reading of the report, it would seem, could leave no doubt in the mind of any person as to whether it deals exhaustively with the sanitary phases of the subject.

The fuel consumption of locomotives in itself and in relation to the work done per unit of fuel consumption is one of the most important points to be determined in connection with locomotive efficiency and economy. This may be determined accurately in test runs, but while numerous methods or systems of records for everyday service are in use, a majority of them are based upon absolutely unreliable information. The result, of course, is that the records and statistics as to fuel consumption and engine performance in relation to fuel consumption, with the conclusions drawn from them, are equally unreliable. The specially weak points are the records of the quantity of fuel delivered to an engine and the amount of this fuel actually consumed in running service (exclusive of roundhouse use). In a committee report prepared by railway officials and presented at the recent annual meeting of the International Fuel Association, in Chicago, the definite statement was made that:

> The supervision of coal placed on tenders and of the performance obtained from the use of this coal is not given anything like the attention it deserves; it is a secondary consideration on the majority of roads.

In view of the enormous amount of the coal bill in the aggregate, and the various difficulties and expenses incident to the purchase of the coal, its distribution, and its delivery upon the engines, it seems strange that these conditions should continue to prevail. But that they do prevail has been shown again and again by papers and discussions presented at meetings of representatives of the railway mechanical and motive-power departments. On some roads, reliable methods of weighing or measuring the coal delivered to the engines are in use, but the report above mentioned stated that a majority of roads use a system which conduces to waste and irresponsibility. At the present time the curtailment of expenses, the reduction of waste, and the economical use of necessary expenditures are matters of very great importance to the railways, but there is abundant evidence to indicate widespread waste of material and money in the fuel consumption of locomotives. The officer who will take this matter in hand seriously and persistently on his own road or division has a great opportunity to show results of a very surprising and equally satisfactory character. As an illustration of the methods which are practically representative of average conditions we quote the following paragraph from the report already mentioned:

> The majority of roads run their engines in what is called "the pool." An engineman takes one engine from the home terminal and returns on another; probably changes firemen half way over the division. The coal is put on the engine by a man who receives a small wage and who has no other aim in connection with this work than to properly coal the engine and have his accounts straight at the end of each week or month. He has full authority to say how much coal the tender will hold, and should he be short of checks for coal given out, he immediately proceeds to take checks for from one-half to two tons more coal than he puts on the engine. This may appear to some as an exaggeration, but we believe that, if we look closely into this matter, we will find the above method is the practice on the majority of roads in America. Under such conditions, a comparative sheet of any kind is valueless and the time of the office man consumed in making out this report might better be used in some more profitable work.

The Metropolitan Sewerage Commission Against the Passaic Valley Sewage Disposal Plans.

A long, expensive and, we believe, an entirely unnecessary, lawsuit between the City of New York and the Passaic Valley Sewerage Commission is likely to result if the recommendations of the Metropolitan Sewerage Commission of New York City, printed elsewhere in this issue, are followed. As many of our readers know, the U. S. Government and the Passaic Valley Sewerage Commission have but recently entered into an agreement (see Eng. News, May 12, 1910) under which the former abandons its intervention in the suit brought by the State of New York against the Passaic Valley Sewerage Commission. It has been generally understood that the State of New York would also discontinue its action. Now comes the Metropolitan Sewerage Commission with a recommendation that the City of New York intervene in the suit, on the grounds that the compromise plans for treating the Passaic Valley sewage before its discharge into New York Bay, and also the proposed supervision of the operation of the sewage disposal works by the general government, are inadequate for the protection of the State and City of New York.

If we are not mistaken, the representatives of the State of New York consented, at least tacitly, to the compromise just mentioned, and therefore are morally if not legally bound to follow the lead of the United States and discontinue the suit. If so, it would appear that the City of New York will be compelled to continue the fight alone, if it enters it at all. But if it has just grounds for legal opposition to the project in question, why did it not protest against the compromise agreement while negotiations were under way? The responsible city authorities must have known the terms of the stipulation several months ago. If not, we see no reason for their lack of information except lack of interest. The Metropolitan Sewerage Commission, it seems, must or might have known the essential features of the stipulation while they were still subject to possible modification. Why, then, did not the city authorities and the Commission seek such changes in the stipulations as would have adequately protected the City of New York, if changes to that end are really needed? Possibly they did, but the Commission, in reviewing the litigation in the course of the report which we reprint elsewhere, makes no mention of any such action.

Coming from the past to the present, the fundamental question to-day is: has the City of New York sufficient grounds for bringing a suit to prevent the Passaic Valley Sewerage Commission from discharging sewage into New York Bay after treatment in accordance with the plans agreed on with the United States? With all due respect for the members of the Metropolitan Sewerage Commission, we think not. To us, and we believe to nine out of ten engineers versed

alike in the principles of sewage disposal and of municipal economics, it seems that the modified plans for treating the Passaic Valley sewage afford all the protection that New York can reasonably expect.

The real menace to the waters surrounding New York is not the modified Passaic Valley project for a scientific scheme of sewage treatment, but rather the indiscriminate wholesale discharge of crude sewage into those waters by New York City itself. When the New York authorities have done as much to keep the rivers and the bay clean as the Passaic Valley Sewerage Commission has agreed to do with the sewage it will discharge, then New York will be in a position to ask the Passaic Commission to do still more, provided New York stands ready to do as much more as it then asks of the New Jersey communities.

No one who is even superficially acquainted with conditions in New York City believes that the local authorities will begin to execute a general plan of sewage purification for many years to come. Quite aside from the grave physical and financial obstacles to such a project there exists and must first be removed the far greater obstacle of public indifference to all questions of sewage disposal and water pollution. Most of the few voices that have been raised on the subject have not been directed toward New York City, but rather toward the communities in the Passaic and Bronx valleys. So far as the construction of sewage disposal works by New York itself is concerned the responsible city authorities have taken no steps and the citizens at large have shown no interest.

In the usual slow course of progress in municipal affairs, it will be years before New York City will have formulated definite plans for treating such portions of its sewage as may require some degree of purification. How long, we will not undertake to predict, but we may note in passing that the Metropolitan Sewerage Commission has spent seven years in preliminary investigations of some phases of the subject and has just secured another lease of life for the purpose of finding out what needs to be done.

In view of the uncertain prospects of the adoption of even a vague general project for improved means of sewage disposal by New York City it would seem both absurd and unjust for it to bring a lawsuit to prevent the Passaic Valley Sewerage Commission from carrying out well-considered plans for sewage treatment which have met the approval of a number of the foremost sanitary engineers in the country and which have the sanction of the U. S. War Department.

Can it be that the Metropolitan Sewerage Commission, in urging this lawsuit, is trying to effect by strategy what it has failed to do by its seven years' accumulation of chemical analyses and its untiring but unsuccessful agitation? That is, is it trying to lead the city into a lawsuit which, since it could never be prosecuted in good faith otherwise, would compel the city authorities to enter at once upon some definite plans for a comprehensive system of sewage disposal? Of course we do not suppose that such is the main object of the Commission, but we can see no chance of a successful issue to the proposed suit unless New York City could show the court that it had at least begun to wash its own hands clean before attempting to compel neighboring communities not only to wash but to disinfect theirs.

LETTERS TO THE EDITOR.

European Views on Special Design in Hydraulic Turbine Manufacture.

Sir: Turbines of "special design" have become quite a fad in America in the last five or ten years, and to have a turbine "designed to meet special existing conditions" is being considered the real thing in turbine equipment. This slogan, which now has penetrated into the farthest corners of our continent, may have originated at the time the first large turbine units were erected at the Niagara Falls Power Co.'s plant by Swiss turbine builders, who, at that time, largely followed the principles of designing all over again a turbine for every new order. The method was copied by some American concerns who started and since promoted this special-design idea in this country.

Curiously enough, at about the same time an opposite movement was started in Europe, as a result of development along theoretical lines, which made it possible to work out a system of turbine series with which really all conditions could be met in a perfect manner. Of course, as in the case in all lines of mechanical engineering, from typewriters and water meters to paper-making machines and locomotives, special machines to meet special unusual requirements may be occasionally made just the same.

This reverse development came very rapidly too, as may be judged from the following statements, which I reproduce here according to the year in which they were issued.

1906.—Viktor Gelpke, a very well-known turbine engineer, says:

In order to subject the diversity of turbine sizes to the requirements of manufacturing and to effect that the pattern store rooms do not grow infinitely, the chapter "normal constructions" originated. . . . With these types it is possible to meet all requirements of head, speed and power, and this so much the more because by combination of several wheels on one shaft the number of possible variations is greatly increased. If nevertheless it is required to build an abnormal turbine, the constructions and design indeed do not present any difficulty; on the other hand it must be remembered that abnormal types are uneconomical and render the manufacture more difficult in regard to work and time required.

1908.—Professor Rudolf Escher, of Zürich, Switzerland, a leading turbine engineer, says:

In manufacturing turbines the aim must be directed towards covering the requirements with a number of different patterns as small as possible, taking the sizes of each series at proper intervals.

1909.—The firm Hansen, Briegleb & Co., Gotha, Germany, is the third largest on the European continent, and is noted for the high grade of its turbine work and for its scientific investigations in the field of turbine design. Here are the views of this concern:

As, of course, not every turbine which leaves the shop can be tested in the testing flume, we proceed according to the so-called series system. For a certain type a test wheel is made and this tested and changed until the results satisfy the highest requirements, otherwise it is rejected. Whenever a satisfactory result is attained, by proportional enlarging or reducing a series of sizes is created, the properties of which are generally even better than those of the test wheel, as the efficiencies increase slightly with power and head.

Often the erroneous theory is encountered that especially in turbine building every case requires a special construction based in the special conditions of flow and that in this very point lies the strength of a good turbine concern; that, therefore, the series system only represents mass-work, does not individualize and therefore is to be rejected. Whoever declares this, does not understand his craft, or intentionally tries to deceive the buying public.

1910.—Doctor-Ingenieur Kröner, in the issue of Jan. 5 of the German periodical "Die Turbine":

The times are past when the designing engineer for every new order laid out a new turbine wheel especially made for the conditions of the special case. A turbine firm conducted along modern lines builds turbines according to the series system.

The above seems to indicate that the leading ideas in turbine building are playing tree tag across the big pond!

A. Streiff,
Engineer Camden Water-Wheel Works.
Camden, N. Y., May 28, 1910.

Criticizing a Floorbeam Connection.

Sir: The floorbeam connection illustrated in your issue of May 19 is perhaps easier to erect than the usual detail and does not require field-rivets through the girder flange, but these facts do not justify its use, as it has several very objectionable features.

The cantilever edge of the cover-plate is not a proper support; the bent hanger-plate will bend as the beam deflects, and as a further result the upper connection rivets will receive an excessive loading. Apparently there are four bolts through the girder web which carry the shear of six shop-rivets in the end connection. The beams are cut at a bevel and milled, a needless expense, since the bent plate does not warrant a milled connection.

In conclusion, the writer does not remember a design inferior in stiffness and strength to the one shown and would inquire what merit is claimed for it.

R. D. Coombs.
1123 Broadway, New York City, May 24, 1910.

The Distribution of a Concentrated Load on a Reinforced-Concrete Slab.

Sir: In designing reinforced-concrete slabs, the writer recently found the critical load to be a 3,000-lb. wheel load upon a slab carried on beams 5 ft. c. to c. with a clear span of 18 ft. The clear span of the slab was 4 ft. 3 ins. and there was a 4-in. wooden block floor upon it. The question arose as to what distance at right angles to the beams can the load be assumed to control. It is obvious that the broader the strip of slab considered in the unit design, the greater is the distribution of load and hence the shallower the beam needed. But the writer is undecided as to the extent of the distribution which the load may take.

Again, he would like to know the opinion of designers concerning the distributing of a concentrated load to a uniform load by means of bars placed parallel to the beams in the central portion of the slab. The bending moment on these bars may be figured by assuming a strip, say, 2 ft. wide and 1 ft. long in the slab between the beams and computing the bending moment for this short section to be taken by the longitudinal bars. Then the short transverse bars between the beam can be assumed to take the bending moment from a uniform load distributed over the section previously considered.

If any of your readers have any advice upon this subject, the writer would appreciate it greatly.

Very truly yours,
Albert T. Smith.
3226 Powelton Ave., Philadelphia, May 22, 1910.

An Arch Dam Design for the Site of the Shoshone Dam.

Sir: The very able article describing the Shoshone dam, by Mr. H. N. Savage, M. Am. Soc. C. E., in Engineering News, Dec. 9, 1909, p. 627, is most interesting to the engineering profession owing to the great magnitude, peculiar location and remarkable profile of the structure described therein. These very striking features of this structure make it particularly adaptable for use "to point a moral and adorn a tale," the moral being that the engineering profession is slow to leave the medieval rut in the matter of the design of dams, the tale being one to point the way out of the rut.

The writer wishes to have it understood at the outset of this discussion that it is not his intention to find fault or to tear down by destructive criticism the works of others, but on the contrary he believes that all criticism of works and designs by engineers should be to the end that the problem in hand, whatsoever it may be, shall be clarified by the discussion and the world left the richer by the increment of definite knowledge gained thereby.

This time and this structure are chosen because the description of it is fresh in the minds of engineers and the structure is heroic in its dimensions and bold in its departure from the lines of dams heretofore designed and built.

A glance at the crown section, Fig. 1, will show without calculation, that as a gravity structure, depending on its base width and weight for stability, it would not be safe but would overturn, the resultant thrust line falling outside of the base at the downstream toe, not taking into account the loose material in the channel, which would not materially alter the stresses.

If the structure is not stable as a gravity section, will it stand up to its load when the reservoir is filled to the flow line? It will; and will be stressed at its weakest point to a very moderate degree, giving it a good sized safety factor.

The design is open to criticism, not because it is not a safe structure, not because of its apparent slender section, but because it is overstrong in parts. It goes without saying that a dam is no stronger than in its weakest point. Now if it is loaded to a less degree in some of its parts than in others, where balanced loading is possible, and the materials in it are constant in quality and strength, which is manifest in this case, then those parts that contain more material than is required for the loads imposed are overstrong and there is consequent lack of economy resulting from the design.

It never has been quite clear to the writer why engineers have progressed by leaps and bounds in all other branches of the profession and at this date are following the methods of the dark ages in the matter of the design of dams. Why is it that the same men, designers of human hives, so big that the daily throngs that occupy and visit them are greater than the populations of considerable towns, planning them without a thought of the opinion of their design held by laymen, will maintain that in the design of a dam there are too many risks to human life to take any chances on any shape but that of one that meets the lay idea of strength and safety, namely, a huge mass of poorly disposed material to resist uncertain and unbalanced stresses; and this, too, in the face of the fact that the load a dam is built to carry is a dead load, exactly determinable and constant, whereas such engineering structures as bridges and buildings with a wide range of variable live loads are free from the interference of the sentimental notions of people without technical training or experience.

The design of the Shoshone dam is heralded therefore as a stride toward the day when dams shall be structures designed for the loads they are to carry, due regard being given to the necessary safety factors, and with that same disregard for the lay idea of safety in mass as is now the practice in all other branches of the profession.

Dams have often been designed with more or less

curvature up stream and still provided with a gravity section, as is the Shoshone dam. The great Cheeseman dam in Colorado, with its 400 ft. radius, has a section placing the resultant thrust line well within the middle third, a structure safe against overturning, according to the stress diagram, with no tension in the upstream toe, but with an unequally distributed base loading, and it is a safe structure. The Big Bear Valley dam in Southern California, with its 300 ft. radius and 20 ft. thickness at the base and slender top, is safe from crushing, though possessing other ills, as has been proved by a flood overtopping it and washing away much of the earth placed against its downstream face. Though of

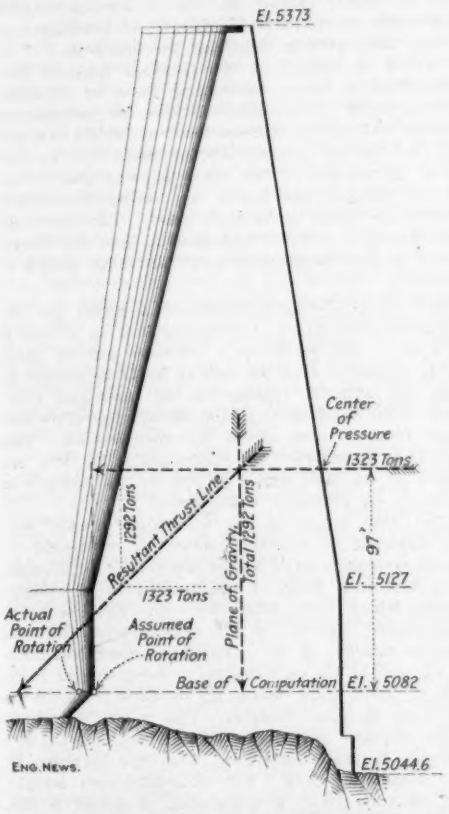

Fig. 1. Crown Section of the Present Shoshone Dam with Resultant Thrusts.

even lighter section than the Shoshone dam (the loading being such as to give it a safety factor of 7.6, which in a building would be considered ample) yet this dam has been considered a wonder of the world because it has stood, while in fact it is one of the strong dams of the country.

A dam has been designed for a great western power project to act as a spillway in a large river, in which two different radii are used, the large radius at the middle and the two smaller ones, about half of that of the middle, for the arches at the ends, making a three-centered arch in plan at the crest. As the thrust varies directly as the radius for any given depth, there will be double the thrust in the larger arch that there will be in the small ones, causing the thrust line to fall outside of the small arches, and lead to the failure of the smaller arches by buckling outward, which is but another illustration of the truth of the saying, "a little knowledge is a dangerous thing," and which is especially so if coupled with a big reputation.

The point to reach is the correct design. The Shoshone dam could have been made just as strong and just as safe as it now is by using one-quarter of the area of section with a corresponding economy of material and cost, if designed as a pure arch dam, such as shown in the accompanying figures. Some authorities on dams make apologies for the use of the arch in dams as being of doubtful effect, tending to give them additional length, but the writer will go on record as to the arch, that any curvature at all up stream has an influence on the strength and stresses in a dam dependent on the radius of the arch and the water pressure due to the depth, and that as soon as any curvature at all is put into the water face of a dam, the change in the direction of the stresses occurs, regardless of the way they may be drawn on the sectional diagrams.

The arch—the circular arch, the concentric ring arch—when loaded by water pressure is the most perfectly loaded form into which material can be placed for it is the equivalent of a balanced load on a column without length, and for this reason no other form should be used for the water face of a dam. The amount of the load or thrust depends on the water pressure due to the depth and the length of the radius of the extrados of the arch. It is the product of the one by the other for any given thrust unit, the water pressure varying as the depth, the thrust as the pressure times the radius.

In any single arch dam the required thickness for any given loading, being a function of the product of the radius of the extrados multiplied by the water pressure due to the depth, in like units, will increase to a point where the product of the decreasing radius and the increasing water pressure gives a loading thrust that will require a maximum thickness of wall, the position of which depends on the rate of radius decrease and the

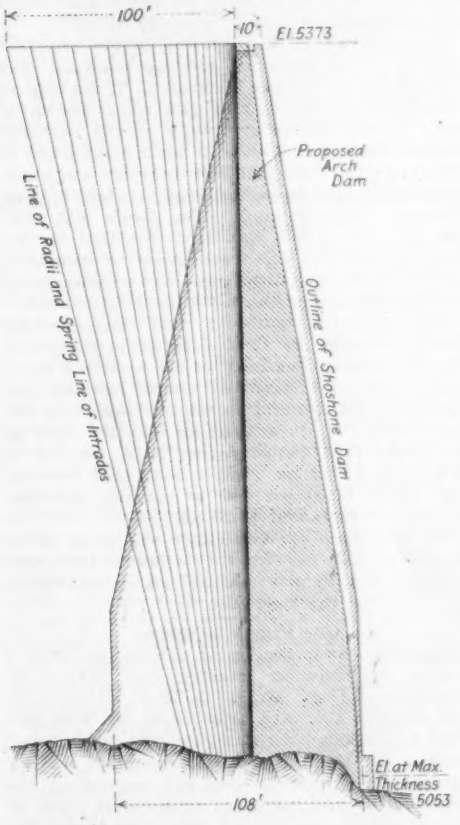

Fig. 2. Comparative Crown Sections of the Present Shoshone Dam and a Proposed Arch Design.

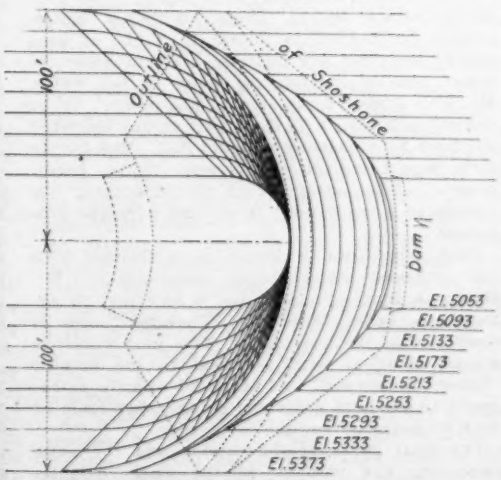

Fig. 3. Comparative Plans of the Present Shoshone Dam and a Proposed Arch Design.

allowed stresses. From this point the walls would decrease in thickness toward the bottom due to the constant decrease in radius overtaking the constant increase in water pressure factor. But for practical reasons the arch can be maintained of equal thickness from the point of maximum thickness to the base of the structure by using a variable radius and constant thickness.

In Fig. 2 is shown a crown section and in Fig. 3 a plan of a structure of the same strength as the Shoshone dam, superimposed on the outline of the Shoshone. The thrust at all points, except near the top, is the same as the Shoshone in its weakest point and is 16.15 tons per sq. ft. or 224.3 lbs. per sq. in. The maximum required thickness is 45.56 ft., giving a safety factor throughout of 13.38, on a basis of 3,000 lbs. per sq. in. as the ultimate crushing strength of concrete or 9.92 on a basis of 2,000 lbs. per sq. in. ultimate strength. If a safety factor of 6 is good practice for structures subject to variable moving and variable live loads, such as bridges and buildings, it should also be good practice when carrying a limited and constant dead load such as the hydrostatic loading of a dam. Should a factor of safety of 10 be deemed the limit, the thickness required for the Shoshone site under a 3,000-lb. ultimate strength would have been 21.44 ft. instead of 45.56 ft. This is a safety factor of a 6.66 with a 2,000-lb. ultimate strength.

The single arch is only applicable to a very limited number of sites and is economical only where the top width of the gorge is quite small relatively to its depth, a condition accentuated in favor of the single arch for the Shoshone site.

The stability of the structure where a single arch is used is not a part of the problem for the reason that overturning cannot occur until the arch is loaded to destruction, the stresses due to the hydrostatic loading and its weight all tending to hold the structure as a unit. To illustrate, let it be assumed that the abutments, the canyon walls, are smooth parallel planes. Then the tendency to overturn would be as a whole, the points of rotation would be the horns of the crescent shaped figure of the plan section of the dam instead of the crown of the intrados at the base as is often shown, proving that any section of a curved dam considered as a straight dam is fallacious, and that the stresses are not as usually shown. To have movement toward overturning, both ends of the arch would have to be ruptured in shear as well as the crushing of the ends, the shape of the figure requiring the latter, and as the shear strength on the plane of the abutments is far in excess of the crushing strength for the same section, safety against crushing by direct compression alone need be considered, the weight load being also always less as well as acting at right angles to the hydrostatic load.

The unit base load due to the weight of the masonry is less in the Shoshone dam as built than it would be in the thinner sections proposed, but even if the base were reduced to a minimum, the hydrostatic load still far exceeds it.

For the greatest economy in material and the direction of the weight stresses a single arch dam should be as nearly vertical as the conditions of the site will warrant, requiring a slight slant in a very thin section to prevent overhang at haunches. In a vertical arch the weight load will act to assist the water load to hold the ends of the arch firmly to the abutments, both acting in the same plane, the angle of the resultant against the abutments making sliding impossible as it is in excess of the angle of friction of the materials. Thus the Shoshone dam would have been better if set across the narrowest rock section of the gorge rather than on a skew, as the natural irregularities of a stripped rock surface, with the combined forces, all acting to prevent movement, make this least section the economical and logical one.

Thus, instead of the selection of any radius at random, and of any slope of walls to fit an even percentage of height or any other dimension, the Shoshone dam would have been of uniform strength if designed on the lines shown on Figs. 2—3. The present dam contains 229% of the material in the design there shown.

Thus, any curvature in the water face of any dam will affect the stresses and their direction in direct proportion to the radius of the water face, and any material put into it in excess of that required to meet these stresses with the given safety factor is waste material.

A single arch is only applicable where the depth, the span and the slopes of the canyon walls are such as to make it more economical in material required than a multiple arch dam, and will be found in practice to apply to a very limited number of sites.

The writer designed and built a multiple arch dam during the summer of 1908 for the Hume-Bennett Lumber Company of Sanger, California, known as the Hume Lake Dam, the first structure of any magnitude in which the arch principle was carried out to any great degree of completeness.

This structure consists of 12 arches of 50-ft. span each, supported on 13 buttresses. It is 677 ft. long on the center line of the crest, 51 ft. high at the toe of the water face and 61 ft. high on the center line, and it closes an area of opening of 17,140 sq. ft. at a cost of $2.68 per sq. ft. It contains 2,207 cu. yds. of 1:2:4 rock concrete, was built in 114 working days, including date of survey, at a total cost of $21 per cu. yd. It has a maximum total load stress of 13.5 tons per sq. ft. or 187.5 lbs. per sq. in., a safety factor of 16 in its weakest point, has no tensile stresses and although it has been tested by the highest freshets in 30 years, has not a crack in it.

The adaptation of the principles in the multiple arch to working conditions for any site is too large a topic to include in this discussion and is "another story," but if

this discussion leads the thought of engineers toward the day when dams are designed as are other structures, for the loads they are to carry, on rational and definite principles, regardless of the fear or favor of the lay idea of strength, not mere masses of obstruction but well designed structures, the purpose of the writer will have been accomplished.

Very respectfully.

John S. Eastwood.

Fresno, Cal., March 28, 1910.

Spring Meeting of the American Society of Mechanical Engineers.

The spring convention of the American Society of Mechanical Engineers was held last week at Atlantic City. The attendance was comparatively small; but this was to be expected in view of the meeting to be held by the Society in England during the last week in July as guests of the Institution of Mechanical Engineers of Great Britain. The professional sessions, however, were well attended, and a number of the papers presented were of exceptional interest and importance.

It is noteworthy that the Society held its summer meeting in Atlantic City just a quarter century ago. Of the 70 members who attended that meeting, five were present at the meeting last week, Messrs. Wilfred Lewis, J. Sellers Bancroft, Ambrose Swasey, Jas. M. Dodge and Oberlin Smith. The three last named have filled the President's chair since the previous meeting at Atlantic City.

The professional sessions last week were held at the headquarters hotel, the Marlborough-Blenheim. The opening session on Wednesday morning was called to order by the President, Mr. Geo. Westinghouse. After the dispatch of routine business a report was presented from the committee appointed by the Council recently to investigate proposed legislation restricting the practice of engineering. The committee reported that the New York legislature had adjourned without action on the Raldiris bill. The committee adopted resolutions to the effect that any legislation affecting the practise of engineering ought to be framed in consultation with representatives of the national engineering societies. It also advised that a special committee of the Society should look after such legislation to the end that the interests of its members may be protected from injury. The matter will probably be taken up by the newly authorized standing committee of the Society on the Relations of the Engineer to the Public, which is shortly to be appointed.

The first paper on the morning's program was "A Shockless Jarring Machine" by Mr. Wilfred Lewis, President of the Tabor Mfg. Co., of Philadelphia. The paper is printed on p. 667 of this issue. However free from shock and jar the operation of Mr. Lewis's machine may be, the discussion of his paper produced a shock and jar of earthquake amplitude. A rival manufacturer of molding machines came promptly forward with a bitter criticism of the machine described by Mr. Lewis and a defense of his own which was couched in terms not often heard in the Society's meetings. The gauntlet thus thrown down was promptly picked up by a former President of the Society who paid the critic back in kind, to the manifest delight of the meeting, and wound up by suggesting that both his own remarks and those of the preceding speaker which had drawn them out ought not to appear in the published proceedings!

What the next belligerent move might have been will never be known, for at this point another Past-President hastily arose in the role of a peacemaker and suggested that it was foolish to continue further the rhetorical combat with the sun shining pleasantly outside and free roller chair rides provided by the Local Committee!

The debate being thus peaceably terminated, good nature was restored by the very unique discussion of the next paper. This paper, by Prof. Walter Rautenstrauch, of New York, recited tests on lathe headstocks, to determine their fitness for various classes of work. The paper was too technical for the audience to clearly understand whether the author's criticism of lathe design was of much practical importance or not; but the discussion offered by Mr. Carl Barth kept the audience laughing from start to finish. Mr. Barth, as many of our readers know, is a mathematician of transcendental ability; but he has the still rarer ability to talk on a subject bristling with mathematics in so humorous a manner as to keep his hearers laughing and their attention concentrated while he presents sense as well as nonsense. Mr. Barth had not great respect for the Professor's conclusions; and he exhibited his own methods of studying lathe characteristics by slide-rules of his own design which he disrespectfully called "guessing sticks"!

The analysis of the stresses in the cast-iron frames of punching and riveting machines was the subject of a paper by Prof. A. T. Jenkins, of Cincinnati. Prof. Jenkins had some models of such frames (which are really curved cast-iron beams) made and broken in testing machines to determine their strength and their points of weakness. The paper was discussed by Messrs. Hess, Christie, Rautenstrauch, Ellis, Lewis and Morris, and the opinion expressed was that the results of tests on small specimens or models of cast-iron are very little guide to the behavior of castings of the same form but much larger size.

The concluding paper of this "machine-shop session" was by Mr. C. K. Lassiter, of Richmond, Va., Mechanical Engineer of the American Locomotive Co., and described recent methods and machinery for finishing locomotive stay-bolts and taper bolts. By these methods machine work on stay-bolts that formerly cost $1.37 per 100 is now done for 13 cts. Taper bolts that formerly cost $5 to $6.50 per 100 to machine are now turned out for about $1.25 per 100.

The afternoon of Wednesday was spent in an excursion and tea at the Atlantic City golf grounds and in the evening an entertainment was given on the Steel Pier.

Gas Power Section.

The Gas Power Section of the Society held a session on Thursday morning with Mr. J. R. Bibbins presiding. Mr. H. G. Reist, of the General Electric Co., in a brief paper on "Gas Engines for Driving Alternating Current Generators," pointed out the electrical difficulties in driving alternators in parallel with gas engines on account of the varying speed at different parts of the revolution and showed that very heavy flywheels made worse the troubles they were meant to remedy. He urged the use of multi-cylinder engines rather than very heavy flywheels.

Prof. Wm. T. Magruder in a paper, "Two Proposed Units of Power," suggested that a "boiler-power" be defined as 33,000 B. T. U. of heat energy delivered per hour by a steam boiler, or steam pipe in the form of steam or hot water. He also proposed the term "gas-power" to be defined as 10,000 B. T. U. of heat energy delivered per hour by a gaseous or liquid fuel. The former term would replace the present "boiler horsepower." The latter would be substituted for "producer horse-power," in dealing with gas producers.

Prof. Wm. Kent in discussion condemned both the proposed standards as unnecessary. Mr. Henry G. Stott proposed that a new unit be established, to be called the "Thurston," and to consist of 34,120 heat units. This unit would be almost identical with the heat in the present "boiler horsepower" and it would exactly correspond to the heat generated by the conversion of 10 KW-hours of mechanical energy.

The final paper of the session and the most important and valuable of the whole Atlantic City meeting was by Mr. H. J. Freyn, of the Illinois Steel Co., and described in detail the experience of that company in the installation and operation of large gas engines using blast-furnace gas. The paper, with appendices, occupies some 90 pages of the Transactions. It was particularly full with respect to methods used for cleaning the gas before its use in the engines. These engines are operated with an average thermal efficiency of 20 to 25%.

The paper excited great interest and was fully and ably discussed. It appeared evident that while there are difficulties in the operation of engines on blast furnace gas, these difficulties are now so well understood and so susceptible of satisfactory treatment that the further extensive utilization of blast furnace gas for power may be confidently expected.

Thursday afternoon's session opened with a paper on "The Mechanical Engineer and the Textile Industry," by Mr. H. L. Gantt. The author maintained there were many branches of manufacturing which had been developed by the inventor and the business man, where the introduction of the methods of the competent mechanical engineer would greatly improve the product and economize the process. In a bleachery in Rhode Island Mr. Gantt has introduced machines comparatively simple of construction which have greatly benefited the business.

Mr. J. A. Capp, of the General Electric Co., presented a paper describing tests of bronzes. The present Navy Specifications for manganese bronze call for an elastic limit of 30,000 lbs. per sq. in. "to be the yield-point measured by the drop of the bar." Mr. Capp showed that there is no "drop of the beam" in testing the yellow metals as there is in mild steel. The curve of the test is so regular and smooth that the elastic limit is only determinable within large limits of error.

Mr. R. D Johnson presented a paper on the "Hydrostatic Chord." The problem to which it related is the design of a pressure pipe of such large diameter that its weight tends to flatten it, and for uniform tension in the pipe and freedom from bending the pipe should therefore depart from a true circle in cross-section. The problem is interesting mathematically, but we know of no case where it has as yet become a problem of practical engineering.

The final paper of the afternoon session was by Prof. E. C. Schmidt, Associate Professor of Railway Engineering at the University of Illinois, and described tests of the resistance of freight trains which were made with the dynamometer car owned jointly by the University and the Illinois Central R. R. The paper described tests of 32 freight trains, ranging in total weight from 750 to 2,900 tons, made up of cars from 16 to 70 tons in total weight. The most important point brought out by the tests was the great reduction in train resistance with the increase in the weight of cars. For example, cars weighing 15 tons have a resistance of about 9 lbs. per ton at a speed of 15 miles per hour, while cars of 75 tons weight have a resistance of less than 3½ lbs. per ton. A similar difference is shown in the resistance of cars empty and the same cars loaded.

A written discussion of the paper, presented by Mr. F. J. Cole, of the American Locomotive Co., pointed out the importance in practical railway operations of this reduction in train resistance due to the use of large cars. The general discussion in the meeting turned upon the question of the bearing of these experiments upon the general problem of journal friction. As stated in Mr. Cole's discussion, the coefficient of friction of car journals appears to vary inversely as the square root of the unit pressure. If this law holds for other journals, it would appear to be important in machine design to adopt as high unit loadings for journals and bearings as can be safely used without heating.

In the evening, the President and Mrs. Westinghouse gave a dinner in honor of Sir William White, of London, Honorary Member of the Society, which was attended by the Council and Past-Presidents of the Society. Following the dinner, honorary membership in the Society was conferred upon Rear-Admiral George W. Melville, U. S. N., retired, Past-President of the Society. The ceremony of conferring honorary membership was the occasion of a very graceful and complimentary address by Sir William White, who, in his former position as head of the British Navy, was particularly familiar with Admiral Melville's work while head of our own Bureau of Steam Engineering. In response, an address by Admiral Melville was given, on the theme "The Engineer's Duty as a Citizen." The Admiral pointed out the difficulty, in the modern complex organization of society, of securing wise action in public matters in which technical

questions are involved. He urged it as the duty of engineers and engineering societies to use their influence to the end that unwise action may be counteracted, and large movements for the public welfare may be guided into such channels as will lead to the largest benefit to the greatest number.

A reception, with dancing and refreshments, consumed the remainder of the evening.

The last session, on Friday morning, was opened with a paper on "Ball-Bearing Line-Shaft Hangers," by Mr. Henry Hess, of Philadelphia. While the bicycle and the automobile have brought ball-bearings into very general use on vehicles and on special parts of moving machinery, comparatively little has been done until recently in the use of ball-bearings on factory shafting. The extra cost of such bearings as compared with plain bearings, and the comparatively small cost of the power used in an ordinary manufacturing establishment, would militate against the use of ball-bearings. Mr. Hess showed, however, that by the use of ball-bearings on line-shafts, the speed of the shaft could be doubled or even quadrupled. This would mean a corresponding reduction in its size, in the diameter and size of the pulleys mounted upon it, and in the length of the shafting hangers. The combined result of these savings make it cheaper, according to Mr. Hess, to install shafting on ball-bearings than on plain bearings. The different conditions obtaining in ball-bearings made it necessary to design a special type of hanger for use with them.

In the discussion upon this paper, some of the makers of ordinary hangers questioned the soundness of Mr. Hess's conclusions. Most of the discussion, however, was devoted to questions as to the availability of ball-bearings for shafting run under various conditions.

Mr. Hess's paper was followed by a paper by Prof. William T. Magruder, of Ohio State University at Columbus, describing tests on friction clutch couplings made by the Falls Rivet & Machine Co., of Cuyahoga Falls, O. Prof. Magruder's tests were devoted to determination of the strength of the couplings under suddenly applied loads, and the methods of determining it. Mr. H. J. Smith, Chief Engineer of the Hill Clutch Co., of Cleveland, discussed the paper at considerable length with reference to its bearing upon the design of his own clutch. Other members discussed the application of the friction clutch to various types of machinery.

The concluding paper of the convention was by Mr. S. H. Weaver, of the General Electric Co.'s Schenectady staff, on "Critical Speed Calculation." The paper discussed the comparatively new problem which arises in the design of shafting for steam turbines and electric machinery run at exceedingly high speeds. It is not possible, practically, to absolutely balance a rotating shaft. At best, the center of gravity will vary more or less from the axis of rotation. At extremely high speeds, the centrifugal force set up by this unbalanced weight causes the shaft to bend, and this bending increases further the deflection of the shaft due to the centrifugal force. When a certain speed is reached, the shaft is set into rapid and dangerous vibrations, and this is known as the critical speed. It is sometimes necessary to run machines higher than the critical speed. Where this is done, the shaft is made just strong enough to withstand the deflection that it suffers as it passes the critical speed, and as flexible as possible to give smooth running above the critical speed. This was done by De Laval in his first high-speed steam turbines, in which the speed of rotation was 7 to 10 times the critical speed. Several writers have discussed critical speed and methods for its computation and determination. Mr. Weaver, in his paper, reduces the theory to a form in which it can be applied directly by the designing engineer, and he gave tables and formulas for use in such cases as occur most frequently in general practice.

In the discussion, Mr. Weaver's paper was given high commendation as a useful contribution in a field where the designing engineer has had little hitherto as a reliable guide.

At the close of the professional session, the names of the committee who will nominate officers for 1911 were announced. The committee consists of Mr. R. W. Hunt, of Chicago, Past President of the Society; Mr. H. H. Vaughan, of Montreal, Assistant to the Vice-President of the Canadian Pacific Ry.; Mr. W. H. V. Roeing, of St. Louis, Mechanical Engineer of the Missouri Pacific Ry.; Mr. F. F. Gaines, of Savannah, Ga., Superintendent of Motive Power of the Central R. R. of Georgia; and Mr. George M. Basford, of New York City, Assistant to the President of the American Locomotive Co.; Past President Swasey, Chairman of the Committee on Arrangements for the English meeting, urged all the members of the society who could possibly do so to avail themselves of the opportunities offered by the English trip. Resolutions of thanks for the hospitalities tendered by the Local Committee concluded the convention.

Annual Convention of the Engineers' Society of Pennsylvania.

In June of last year the Engineers' Society of Pennsylvania, which at that time had just succeeded the old Engineers' Club of Central Pennsylvania, organized a so-called "Convention Section"—a somewhat novel feature in societies of this sort. This Convention Section had a separate chairman, and included in its membership any engineer who wished to register at the meeting held for three days at Harrisburg at that time. The meeting was very well attended by engineers from all over the State of Pennsylvania, and as a result of the interest taken at that time there has grown up in Pennsylvania a decided movement towards the organization of a State Society which should have as subsidiary members various local clubs scattered throughout the state. This idea has been in the minds of a great number of engineers who attended the last year's convention, and was this year brought nearer to fruition in the Second Annual Convention of the Engineers' Society of Pennsylvania held in Harrisburg, June 1 to 3.

The Convention of this year was called by the Engineers' Society of Pennsylvania, and to it were invited any engineers in the State of Pennsylvania and all of the separate local societies of engineers which have their respective headquarters in the various cities of the state. This year's meeting, as did that of last year, consisted largely in the presentation of lectures, mostly illustrated, upon various engineering subjects and upon the discussion of the formation of the State Society mentioned above. In the endeavor to perfect this state organization, a committee, consisting of representatives from engineering societies from all parts of the state, was appointed early in the convention to report upon a constitution for the State Society and for a method of bringing the minor societies under a unit jurisdiction. This committee on the last day of the convention brought in a report which consisted of a suggested constitution for the main society and for any one of the subsidiary societies. This constitution was adopted by the convention and is now to be sent to each of the local societies for discussion. The exact method by which the organization is to be accomplished depends largely upon the attitude of the already formed local engineering societies.

In brief, this constitution provides for a state engineering society of Pennsylvania, and for a number of local engineering clubs covering different territories throughout the state, each of which clubs is to be a subsidiary association to the main state society. Each club is to elect its own membership and officers, and at the same time is to elect a certain number of delegates to the State Society, which delegates go to make up the house of delegates, which, with the executive officers elected by ballot throughout the state, governs the State Society. Each member of a local club pays dues to the State Society, said dues to be applied mainly to the publication of a monthly journal of the State Society, and each member also pays dues to his local society for its maintenance.

There are at present in Pennsylvania four large societies—the Engineers' Society of Pennsylvania at Harrisburg, the Engineers' Clubs of Philadelphia and Scranton and the Engineers' Society of Western Pennsylvania, at Pittsburg. Each of these societies is at present independent, and it is somewhat doubtful to what extent they will be willing to make themselves subsidiary to the main central society, but there seems to be among the members of each of these societies a strong feeling that an organization centralized and representative would have a much wider influence in furthering the interests of the engineers of the state and of directing, to some extent, possibly, the legislation in which engineers are interested.

Aside from the mutual benefit to be derived from centralization and unification of the local societies, it was very evident that the moving spirits in the proposed change feel that the time is now coming when the engineer should exert more of an influence upon those public affairs in which he is interested and about which he is expert.

As an example of the attitude of the engineers of the State of Pennsylvania, the following quotation from the address of Mr. J. V. W. Reynders, President of the Engineers' Society of Pennsylvania, is of interest:

> Our national engineering associations have confined their investigations to purely technical subjects, making no effort to reach and influence public opinion in matters coming within the province of engineering. The flood of ill-advised legislation of recent years indicates the need of a broader policy in this respect. I may venture to suggest, moreover, that there is a large sociological field in which engineers are vastly interested. In the solution of problems arising in this field, engineers are in position to offer valuable facts drawn from their own experience.

In the same vein was the address of Prof. J. P. Jackson, of Pennsylvania State College, who was Chairman of the Convention:

> There are innumerable questions of vital import to the people of this country and of the world which can only be answered intelligently by the engineer or industrialist. Why should the medical associations be alone held responsible for insisting upon proper systems of sanitation and water supply, when the creation of proper methods and their execution lies so largely in the hands of the engineers? Why should not the people have the advantage of teaching and instruction from the engineers with regard to the proper regulation and handling of the great projects of public utilities, transportation, etc.? Why should not the engineer be held strictly accountable for the proper training of the industrial classes to lives of the highest and best usefulness. Is it not a shame upon him that to-day the great bulk of our boys are turned loose from the grammar or high schools without ability to apply either their hands or minds to a useful task; and further that no way is available whereby many of them may better their condition or make themselves more useful to their communities?
>
> Likewise, why should not the engineers be held strictly accountable for the product turned out by such magnificent institutions as the Technical high school, here in Harrisburg, and the more advanced engineering instruction under the control of the State? At present he feels free to criticize with the freedom of perfect irresponsibility. Should not all results be laid strictly at his door? Who, so much as the engineer, should be held accountable for conserving the fuel, water, and other natural resources of the country; for improving our roads; and for many other State functions of a like nature vital to the people?
>
> But we are not met here to-day to carp and complain of the shortcomings of the past; but rather to preach and practice a new doctrine. We are met not so much to listen to the eminent scientists who will lecture in this noble hall upon subjects which will both please and instruct, but more for the purpose of finding ways and means whereby we, the engineers of the great Commonwealth of Pennsylvania, can apply our technical knowledge and training to the best welfare and interests of her people.
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> . . . . . .
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> In the manner suggested does this society propose to lead public opinion in Pennsylvania. This is not to be accomplished by political machinations and lobbies but rather by open discussions, the public statement of facts, and by assumption of our proper responsibility for such elements of our government and development as we are, by learning and professions, most fitted for.

In pursuance of the idea suggested by Prof. Jackson, the convention authorized its Chairman to appoint for the ensuing year committees upon

such subjects as Public Structures, Lighting, Railways and Waterways, Public Health, Conservation, Industrial Education, Mines and Mine Safety and Legislation. These committees are to be made up of representative engineers from various sections of the state and it will be their duty to keep informed as to progress in their respective subjects and report to the Convention, or eventually it is hoped to the State Society, the results of these studies, for possible reform or agitation.

In line with this intended interest in public affairs which concern the engineer the Convention passed a resolution endorsing the work of the United States Reclamation Service and its heads, Mr. Frederic H. Newell and Mr. Arthur P. Davis. This resolution was as follows:

BE IT RESOLVED, That this Convention, representing the Engineers of the Commonwealth of Pennsylvania, has entire confidence in the ability and integrity of Mr. F. H. Newell, the Director of said Reclamation Service, and Arthur P. Davis, Chief Engineer thereof, and recognizes the administration and operation of the Reclamation Service by these gentlemen as of the very highest order, and as one of the greatest achievements of members of the engineering profession in this country; and

BE IT FURTHER RESOLVED, That this resolution be spread upon the minutes of the Convention, and that copies, suitably engrossed, be forwarded to the President of the United States, the Secretary of the Interior, and the Director of the Reclamation Service.

Owing to the courtesy of the Pennsylvania Legislature, voiced in a joint resolution of both Senate and House, the meetings of the Convention were held in the magnificent House of Representatives Chamber of the new State Capitol. It would be difficult to find a more nearly perfect hall in which to hold a convention, and the act of the Legislature was much appreciated by the members of the Convention.

In addition to the regular meetings of the Convention, there was a largely attended banquet and two smokers, one to the members of the Convention and one to the exhibitors. Special entertainments and excursions were also provided for the ladies attending the meeting.

Code and Licensing Law.

At the meeting last year there was a lengthy discussion of a code for engineers and of a law regulating the practice of engineering in the state and a committee was appointed to study the question and to report upon it at this year's Convention. It was expected that there would be much time given over to this matter this year but the following self-explanatory report of the committee postponed any action or even any discussion to some later date.

The Joint Committee of the Engineers' Club of Philadelphia, the Engineers' Society of Western Pennsylvania, the Scranton Engineers' Club, and the Engineers' Society of Pennsylvania, appointed by these respective societies on request of the engineers assembled in convention at the Capitol in Harrisburg, in June, 1909, to consider the matter of a professional code and to report a draft of a law for the regulation of the practice of engineering in Pennsylvania, begs leave to report that it has organized and devoted much time, thought, and research to this important subject. At the present time, the question of licensing engineers is receiving the attention of the members of the profession in a number of states in the union. In some instances this study has been forced upon the engineers by the premature enactment or proposed enactment of laws framed by citizens not members of the engineering profession.

Your committee is sensible of the duty which it owes to the Engineers' Society of Pennsylvania and it believes that the work before it of proposing a code and draft of a law is so important that further time should be granted for consideration.

The American Society of Civil Engineers has appointed a committee which is now at work with the idea in view of reporting the general lines upon which uniform legislation should be effected throughout the country. This undertaking is eminently proper and in cooperation with other American societies will no doubt result in the formulation of a satisfactory draft of general provisions, after which legislation affecting the practice of engineering may be safely patterned. While the formation of a general code is properly the function of the national societies, the engineers of each state should decide whether they wish such a code embodied in the laws of their state and if they so wish, should see that it is embodied in the proper form.

Your committee suggests the expediency of postponing the submission of a draft of law by it until after the report of the American Society of Civil Engineers shall have become available. However, it is respectfully suggested that the committee's work would be materially assisted by a free discussion of the entire subject by the engineers assembled at this convention. In view of the circumstances it has been unanimously agreed by the members of the joint committee that the interests of all concerned will be subserved by the postponement of a report by the committee on a code and draft of a law, and further time is therefore requested. The report should in the opinion of your committee be prepared in printed form suitable for distribution through all local societies to all members of the different branches of the engineering profession in Pennsylvania in advance of its presentation at a future convention of the Engineers' Society of Pennsylvania, in order that the fullest opportunity may be given for its discussion at that time.

Lectures.

As was the case last year, the technical proceedings of the Convention consisted entirely of illustrated lectures, each covering some special branch of engineering, but in few cases bringing out any pronounced discussion from the floor.

Two of the lectures were upon road building and maintenance, one by Mr. L. E. Boykin, of the federal Office of Public Roads, and one by Mr. Joseph Hunter, State Highway Commissioner of Pennsylvania. Each discussed the general subject of roads and illustrated by views some particular roads built under the supervision of the respective offices. The main feature of both lectures was the opinion of the lecturers that there should be a centralized supervision of road construction so that more scientific methods could be applied and more unified systems be located.

Mr. J. A. MacMurchie, of the Westinghouse Machine Co., Pittsburg, delivered an illustrated lecture on the Mellville-MacAlpine reduction gear for turbines, covering practically the same field as have the articles upon this gear in the recent issues of Engineering News. Dr. Clayton H. Sharpe, Director of the Electrical Testing Laboratories of New York, in his lecture entitled "Illumination," outlined the methods of testing illuminants and the requirements of lighting various interiors and exteriors. Prof. A. Lawrence Rotch, Harvard University, the Director of the Blue Hill Metereological Observatory, delivered a lecture entitled "The Aerial Ocean and Its Navigation" in which he described in some detail the results of years of experimentation in determining the nature of the air immediately above the earth's surface. In conclusion, he covered, somewhat rapidly, the progress of aerial navigation from Montgolfier to Curtiss.

On the last evening of the Convention Dr. Samuel G. Dixon, State Commissioner of Health of Pennsylvania, delivered a popular lecture on "Sanitation." This was thrown open to the public and it is a hopeful sign of popular interest that the large meeting hall was crowded. Dr. Dixon's lecture was intended to bring to the people the importance of a proper respect for the laws of sanitation, and was illustrated by photographic examples of congested housing and filthy surroundings as well as the improved conditions brought about by proper supervision and an observance of sanitary laws.

The list of lectures was concluded by one by Mr. J. G. Callam, of the Arthur B. Little Co., Boston, Mass., on "Rotary Blowers for Blast Furnace Service." This traced the development of the blower from the man-trod skin bellows of the Egyptians to the gas-driven rotary blowers now in use at Gary, Ind.

Exhibition.

In connection with the Convention there was held an instructive exhibition of engineering machinery and appliances, with some 90 firms in attendance. This exhibition was held in the car barn of the local traction company, a reinforced-concrete building of separately-molded members, which was described in Engineering News, Dec. 9, 1909, p. 648. The long, narrow plan of the building which permitted of two aisles of exhibits, its fireproof construction, which added to its safety as an exhibition hall and its convenience of entrance on the ground floor, all combined to make it an ideal building for the purpose.

Annual Convention of the International Railway Fuel Association.

This association, which is devoted mainly to questions of railway fuel supply, held its second annual meeting on May 23 to 26, at the La Salle Hotel, Chicago. The secretary's report showed that while the society is young it has a membership of over 300 and a cash balance of $696. The opening address was by Mr. H. T. Slifer, M. Am. Soc. C. E., General Manager of the Chicago Great Western Ry. The president, Mr. E. McAuliffe (General Fuel Agent of the Chicago & Eastern Illinois Ry.) called attention to the great losses and difficulties resulting from the frequent shutdowns at coal mines, making it necessary for railways to store great quantities of coal to provide against threatened periods of suspension, and also to transport and distribute great quantities of coal at unfavorable seasons. A resolution was passed asking Congress to give the Interstate Commerce Commission control over coal production, and to extend the law relating to railway labor troubles to cover those of coal mines.

The following committee reports were presented: (1) Methods of Securing Efficiency in Fuel Consumption (Chairman, D. Meadows, Asst. Master Mechanic, Mich. Cen. Ry.); (2) Methods of Purchasing Coal (Chairman, W. H. Huff, Victor-American Coal Co., Denver); (3) Grade of Fuel Most Suitable for Locomotive Use (Chairman, J. G. Crawford, Fuel Engineer, C., B. & Q. Ry.); (4) Uniform Blanks for Fuel Station Reports (Chairman, N. M. Rice, Gen. Storekeeper, A. T. & S. F. Ry.). There were also two papers: (5) Kindling Locomotive Fires, G. C. F. Richardson, Asst. Supt. M. P., C. R. I. & P. Ry.; (6) Mechanical Preparation of Fuel, G. H. Stoek, Professor of Mining Engineering, Univ. Ill.

Most of the reports were based upon replies to circular letters, and presented reviews of these replies. The one relating to the purchase of fuel was of a general character, presenting the relations between the producer and the railway, with such matters as car supply, shipment and storage of coal, etc. The discussion on Mr. Crawford's report showed that several railways are using slack coal at pumping stations with marked economy, and also that it is desirable to maintain a uniform quality (whether good or bad) on a division, as this conduces to the best and most economical use of coal by the firemen. We shall give later an abstract of Mr. Stoek's paper, and we give below abstracts of two of the reports.

Grade of Fuel Most Suitable for Locomotive Use.

From the standpoint of the operating department of a railroad company, the most desirable coals are those which cost the least per ton-mile; cost f. o. b. mine, cost of haulage, cost of handling at chutes, cost of firebox repairs, cost of handling ashes, cost of delays to trains caused by poor coal and all other points directly and indirectly affecting the cost of coal per ton-mile, not limiting the cost of coal per ton-mile to such costs ordinarily charged in operating statistics.

Where coals of widely different character or heat value are used, it is not advisable to use them indiscriminately but to keep them grouped so that an engine district will receive only one character of coal. This will require two kinds of coal to be kept only at the chutes at division points separating engine districts using coals of different character. This factor should be considered in determining the tonnage of coals to be used, so that it will not be necessary at times to send coal of 70% rank into a district regularly supplied with 100% coal.

There do not seem to be sufficient advantages to offset the disadvantages of supplying passenger engines with lump coal and engines in other service with mine run. It is desirable to keep a uniform grade as well as a uniform character of coal in an engine district. There are probably some cases where it is necessary to furnish passenger engines with lump coal and freight engines with mine run, but this should only be done to avoid possible engine failures resulting from poor coal.

Mine-run coal containing a large percentage of very fine screenings is probably not as economical as a 1¼-in. screened lump coal, but your committee has been furnished no information which will warrant it in stating what size screenings and what percentage of that size screenings are detrimental to locomotive coal. The size to which coal should be broken depends on its nature,

but the replies to questions favor breaking to the size of 4-in.

Methods of Securing Efficiency in Fuel Consumption on Locomotives.

The supervision of fuel economy is generally looked after by the road foreman of engines and his assistants, they reporting to the master mechanic or superintendent of motive power. Enginemen should be shown how many pounds of coal are used per locomotive, or thousand ton-miles, and comparisons made. The methods of doing this vary considerably. This showing, or rather comparison, brings about a rivalry for a good record, and also shows the poor men who need special attention.

All roads evidently attempt to bring about close co-operation between the engineman and fireman, instructing them that it is only by united efforts that the best results can be obtained, and the best means to this end is to feed the fire as lightly as possible, consistent with the service required, to feed the water to boiler evenly, to keep the fire clean, avoid waste of steam from pop valves by having a full understanding of work to be done, where steam will be shut off, etc.

The breaking of coal so that there are no lumps larger than 3 or 4 ins. square has a great influence on fuel economy. Three railways say that coal which has passed over a ¾-in. screen will show the greatest economy. Others state that this depends very largely upon the coal, as coal from some fields contains such a large percentage of impurities that better results are obtained by this screening. On the other hand, where the mining conditions are favorable, better results are obtained by burning run-of-mine coal.

The most valuable essentials of fuel economy outside of the purchase price consist in keeping the engines in thorough repair, eliminating all leaks, blows and waste of steam, ample grate area and heating surface, good terminal facilities for caring for power, enginemen trained to burn fuel economically, the operating department eliminating unnecessary delays, see that the coal delivered is the coal specified in the contract, and lastly, by keeping everlastingly at it. To prevent waste when on the road, some railways cover all shaker-bar holes in deck plates and a flanged apron between the engine and tender is used.

As to the effect of the weather upon storage coal exposed for any length of time, all the railways replying agree that coal stored will depreciate in value, some classes more than others. Claim is made that on account of losses by exposure to the air and by handling, some coals will depreciate 20% in 60 days. Your committee believes that with some coals this high percentage of loss is reasonable. Generally speaking, however, 5% should cover all depreciation. A great deal depends on the manner in which the coal is stored, also how picked up. If coal is picked up with a clam-shell or any other mechanical device, they may gather up quantities of gravel, clay, or other non-combustible substances and the value of the coal is depreciated greatly.

A number of roads keep inspectors at the mines, whose duties are to closely watch the loading and see that cars are properly cleaned before placed under the tipple, the inspector having authority to reject all cars which contain a high percentage of non-combustible matter, slack, etc. These roads claim that they receive a better grade of coal, due to this inspection, also a better loading of cars, thus requiring less cars to haul the same tonnage. The majority, however, put it up to the coal company to see that the coal is properly prepared and cleaned. It would appear that the latter method is the wiser, for various reasons.

Instructions to enginemen and firemen by class instruction, progressive examinations, the distribution of books on combustion, etc., are beneficial, but the greatest benefits are derived from individual instruction by competent men who are practical enginemen and fuel specialists, and devote their entire time to instructing firemen and the less efficient engineman. Each instructor's territory should be sufficiently small to enable him to reach all under his charge at least once each month.

A locomotive performance sheet showing consumption in pounds per ton-mile per hour would create a rivalry among the enginemen that would bring about good results. This gives the men a fair showing for work done. A performance sheet showing the engine miles made per ton of coal is not worth anything, and a sheet on the ton or thousand ton-mile basis is very little better. Nor are any of these of value if there is not some fairly accurate method of determining the amount of coal used by each engineman each trip. Some roads weigh the coal put on tenders, or have some fairly accurate way of measuring the coal. On these roads a performance sheet based on the ton-mile per hour basis puts into the hands of the master mechanic or road foreman something fairly accurate and reliable. It also will assist the road foreman in locating men and engines that need attention.

The supervision of coal placed on tenders and the performance obtained from the use of this coal is not given anything like the attention it deserves; it is a secondary consideration on the majority of roads. Until there is some accurate method of knowing how much coal is put on tenders, what percentage of it is consumed at the engine-house and what amount of work is done for coal consumed, the desired results can scarcely be expected.

A Reinforced-Concrete Low-Head Water Tank and Its Waterproofing.*

By H. F. BLOMQUIST.†

The city of New Ulm, Minn., has just completed a reinforced-concrete reservoir of 1,000,000-gal. capacity, a cylindrical structure 75 ft. in diameter with the walls 30 ft. high, and covered with a conical concrete roof. The ground on which the reservoir is built consists of hard clay well drained by natural drainage, and upon this clay was spread a layer of stone with an average thickness of 12 ins. the voids of which were filled with a wet, fine-grained concrete poured in. This formed the foundation for the floor which is 10 ins. thick, and reinforced near the surface with expanded metal of No. 16 gage thickness and 3-in. mesh. The floor is bound to the walls by means of 1-in. round steel rods 8 ft. long bent so as to extend 4 ft. into the floor and 4 ft. up into the walls. These were placed 12 ins. apart throughout the circumference.

The walls are 20 ins. thick at the bottom and taper to 15 ins. at the top, with the batter on the outside. They are reinforced with 123 1⅛-in. and 40 1-in. round steel rods rolled to the required radius and placed horizontally, and by 20 upright supports made of steel angles with lacing bars, which served as supports for the horizontal rods during the time of construction, as well as vertical reinforcement in the walls. The horizontal reinforcement is sufficient to take all the stress without assuming tension in the concrete, or counting on the support of the earth embankment on the outside.

The roof consists of a conical concrete slab 3 ins. thick and reinforced with No. 12 gage, 3-in. mesh expanded metal, and is supported by eight trusses radiating to the wall from a center pillar. The trusses are bound together with steel I-beams as purlins 5 ft. apart. The steel trusses are 6 ft. high from c. to c. of chords at the ends which rest on the center pillar, and taper down to 3 ft. at the ends resting on the walls.

Since it was of the utmost importance that the walls and the floor should be water-tight, special care was taken during the construction to grade the aggregate for the concrete. It has been found by experiments that the densest concrete can be made when rounded pebbles varying in size from about ¼-in. to about 2½ ins. are used instead of broken stone on account of the ease with which such pebbles will move about in a quaking mixture while it is being worked in place, and adjust their positions so as to form the least amount of voids. For this reason pebbles were screened from a gravel bank and used instead of crushed stone for the walls and upper part of the floor, and the sand used was a mixture of very coarse and ordinary fine sand. To reduce the permeability of the concrete to a minimum, 20 lbs. of hydrated lime was used to every barrel of cement, and after the forms were removed the walls were brushed and cleaned with steel brushes, and two coats of cement plastering were applied on the inside. The mortar for the plastering consisted of one part cement, two parts of sand, hydrated lime to the extent of 10% and Medusa waterproofing compound to the extent of 3% of the cement used.

The proportion used for the concrete in the walls and the upper 4 ins. of the floor was 1:2:4 and this proportion of concrete together with the plastering has apparently made the walls water-tight, as no leakage has been noticed up to this time except a small leak in the bottom shortly after the reservoir was filled, which was due to an imperfect bond at one point between old and new concrete. This however did not cause serious trouble.

The forms for the walls were made in sections about 12 ft. long by 2½ ft. high, and the inside and outside parts were bound together by means of ½-in. rods extending through the walls, which were removed after the concrete had acquired its initial set. The holes formed by the rods were afterwards filled with a strong cement mortar. Only one round of forms was used, as the contractor found that he could work most economically filling the forms in one day and removing them the next, and set them up for the pouring of concrete again on the third day. When it was necessary to build scaffolding two days were taken to remove and set up the form and build scaffolds.

The bond between old and new concrete was made by brushing the old concrete thoroughly clean and pouring on a neat cement grout just before pouring on the new concrete.

The outside walls are protected by an earth embankment which extends to within 10 ft. of the high water mark and has a slope of 2 to 1 on the outside. This was sufficient protection during the past winter to keep the water from freezing.

*From a paper in "The Minnesota Engineer" (a publication of the Engineers' Society of the University of Minnesota), March, 1910.

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The Economic Aspects of City Planning.*

By BENJAMIN C. MARSH.†

City planning is designed to secure the orderly development of a city so that each section will be arranged for the purpose for which it is best and most economically adapted, and so that a harmonious entity will result. This development must be for the common good and not for private gain.

City planning in this country has been chiefly aesthetic. In foreign countries much more emphasis has been laid upon the need for improving the condition of living of the poorer classes and setting a high standard of housing for unskilled wage earners.

We have inverted the procedure in this country. American cities farm out their poor to be exploited by the land speculators. The American system of laissez faire has resulted in permitting the shrewd and grasping real-estate speculators and tenement sweaters to make fortunes from the poverty-stricken members of the community.

These are some of the important features of comprehensive city planning:

(1) Proper housing for the city's masses for a reasonable proportion of fair wages, and within easy access of their work.

(2) Direct and adequate roads connecting the main business centers of a city with smaller roads of such width and construction as not to impose an unnecessary and burdensome cost upon the occupants of small houses.

(3) A proper system of water-supply, sewage disposal and of pipes and wires.

(4) The economic location of factories and the prohibition of factories in districts where they will be an injury to the neighborhood; and as a necessary corollary, the provision of means of carrying freight.

(5) The elimination of the cost of carfare to the working population, so far as possible.

(6) The decentralization of the city's business, pleasure and educational interests.

(7) The provision of adequate parks, playgrounds and open spaces with space for public buildings to furnish not merely sites but settings.

(8) Such control over the location and volume of buildings for manufacturing and office purposes as will enable the city authorities to anticipate and provide adequate means of carrying passengers.

(9) The control of the development of new and unbuilt sections of a city, and the incorporation of adjacent area so that their development may similarly be controlled.

The standard of housing for the working population is a matter which must be determined by each city and may require variation for different sections of the same community. In order to secure the harmonious development of a city in the interest of all the citizens, including the owners of the valuable property lying in the business sections of great cities, it is necessary that we should have a proper extension of the police power of the city, and that this should involve not merely regulations as to fireproofing, but also restrictions on the use of buildings. In addition there should be an extension of the taxing power of the state, which should be considered part of the police power. Under the police power there should be included an extension of the control of the city over the location of factories.

The most important point to be considered in city planning is the preservation of the outlying sections of the city from the duplication of those evil conditions recognized and deplored in the built-up sections. To prevent the duplication of the deplorable conditions of most cities requires not only a reasonable amount of genius but equally a considerable amount of courage on the part of city officials, and this is the task to which all American cities are summoned.

The elimination of the cost of carfare to the working population is a most important feature of proper city planning. Most American cities have lost their heads over rapid transit and are obsessed with the idea that daily wage earners want to spend an hour and a half or two hours a day riding to and from their work. The cost of transportation is a serious economic waste. There are nearly 700,000 workers in factories in New York. A minimum of $30 each for carfare means a waste of more than $21,000,000 a year, which is nearly 1/11 of the total wages paid in 1905 in all manufacturing concerns in the city. The time spent on the cars is also a serious loss which should be prevented by the distribution of factories and offices and the decentralization of the various interests and business sections in great cities.

RAILWAY GARDENING on the Canadian Pacific is said to have been entered on to such an extent that about 80,000 packages of flower seeds were distributed this year among the station-masters. It is stated that 2,000 gardens are maintained.

*Abstract of an address before the meeting of the Municipal Engineers of the City of New York, Wednesday, May 25, 1910.

†Secretary Committee on Congestion of Population, 50 Church St., New York City.

Steel Barges for Transporting Steel Products on the Ohio and Mississippi.

Quite a number of steel boats and barges have been built during the last few years for freight transportation on the Ohio River. They were built chiefly for carrying coal, sand, oil and other bulk commodities. Some few have also been in the service of handling steel products, among them particularly a fleet of 30 steel barges of the American Steel & Wire Co. which brings coal down the Monongahela to the mills but on the return trip carry billets from the company's Shoenberger Works to Rankin and Braddock. These particular boats have been in use for several years. They were built by the American Bridge Co., which company has in the last few years constructed a total of some 60 or 70 steel barges for Ohio and Monongahela river service.

The same builders have now under contract a group of ten steel barges, 200 × 36 ft., with 9 ft. maximum draft, for exclusive use in handling steel products. They are to be in the transportation service of the various subsidiary companies of the United States Steel Corporation, in the Pittsburg district, carrying steel products down the river as far as New Orleans. For this purpose they must be capable of handling rails and long structural material in addition to wire, fencing, pipe, nails and other light material.

A yearly tonnage of 40,000 to 65,000 tons of the lighter material and up to 150,000 tons of rails from the works referred to is now being carried via the river to southern ports, under an arrangement with the Monongahela Consolidated Coal & Coke Co. Wooden barges are used. Only two round trips per year are now being attained by the barges in this service. It is thought by those in charge, however, that improvement in conditions can bring this up to five round trips to New Orleans per year, or even more. This would make possible sending a much larger tonnage by river, perhaps over 250,000 tons annually.

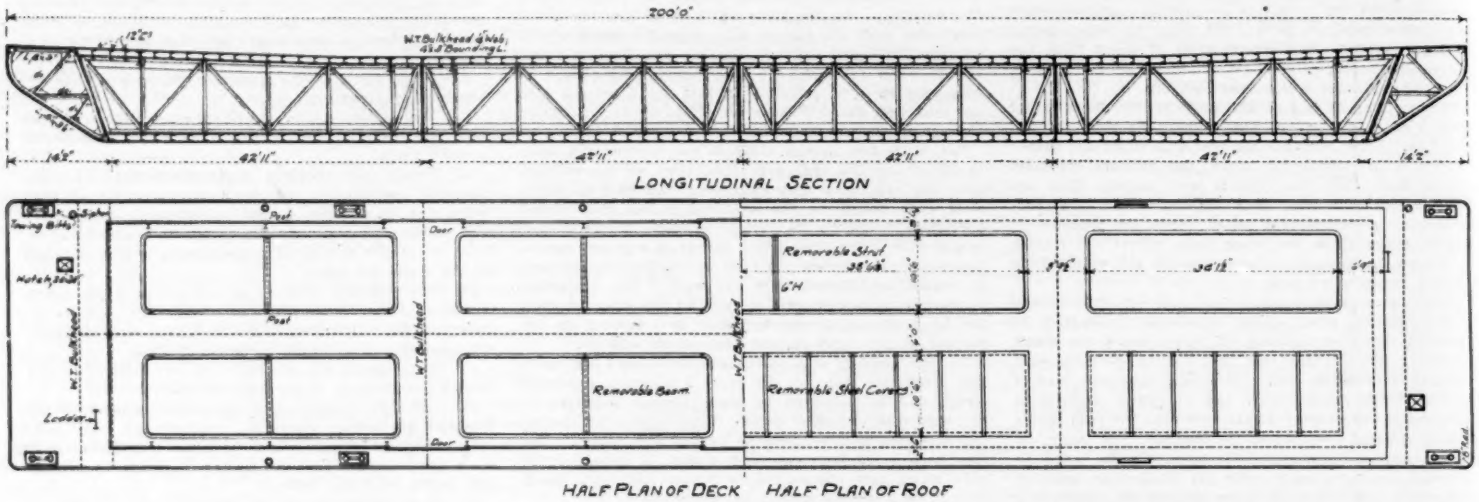
The ten barges now being built are represented by the drawing herewith. They are of symmetrical scow shape, which was decided upon as most suitable for duty. The whole construction is made up of standard steel shapes and plates, without any special sections. The only wood employed is a 4-in. wood floor in the hold.

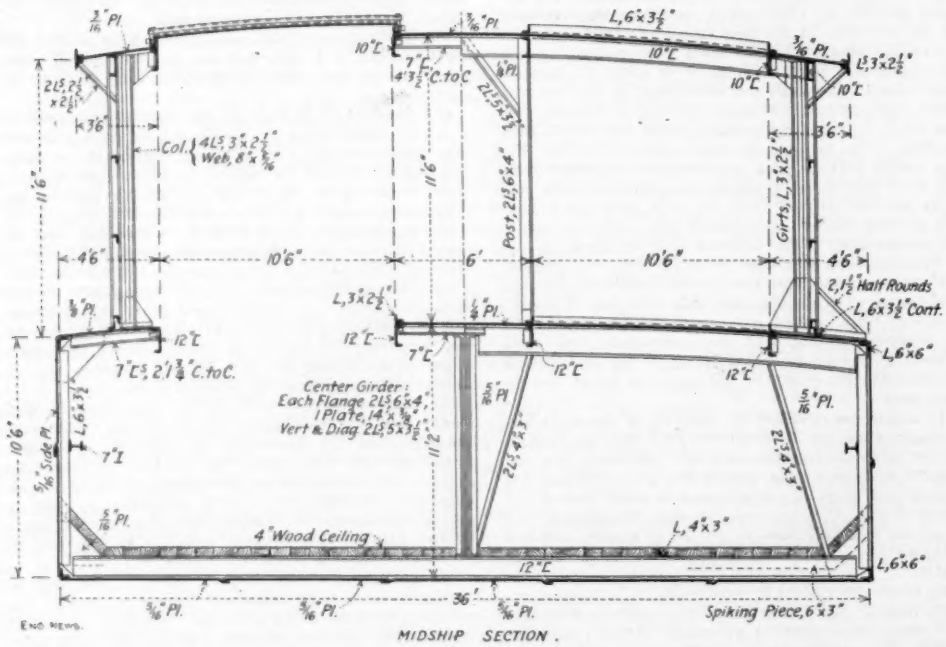
The framing includes a longitudinal truss along the middle line. This and five transverse watertight bulkheads divide the hold into eight compartments. Hatches in the deck and in the deckhouse roof over each compartment are made of such length as to admit 33-ft. rails. For enabling still longer members to be carried as a deck load, the two middle roof hatches are arranged to give a continuous opening; through this, rails in 60-ft. lengths and structural material in lengths up to 70 ft. can be lowered to the deck.

The barges are 200 ft. long over all, 36 ft. broad, and 10½ ft. deep. Bow and stern have a sheer of 18 ins. The deck is crowned 8 ins. transversely. The light draft is 26 ins., and as already stated the full-load draft is 9 ft., leaving a freeboard of 18 ins. Thus the load capacity is about 1,500 tons. Other dimensions and sections may be obtained from the drawings.

A deck-house or cargo box covers the greater portion of the deck, being needed to realize the full weight capacity with the lighter classes of steel products. This is also framed of steel; its sides are of corrugated sheet steel. Alongside is sufficient space for trucking small material along the deck to the doors, there being three sliding doors in each side and one in each end wall.

As illustrating further the growth of steel barges on the Ohio and Mississippi, it may be said that the American Bridge Co. has recently completed three barges for carrying oil in bulk,




Col. 4 L's 3"x2½" Web, 8"x⅝"
Post, 2 L's 6"x4"
Girts, L 3"x2½"
2 L's 6"x4" I Plate, 14"x⅜" Vert & Diag. 2 L's 5"x3½"
4"Wood Ceiling
Spiking Piece, 6"x3"
MIDSHIP SECTION.

PLAN AND SECTIONS OF 1,500-TON STEEL BARGE FOR TRANSPORTING STEEL PRODUCTS FOR U. S. STEEL CORPORATION ON THE OHIO AND MISSISSIPPI RIVERS.

for service at New Orleans; ten coal barges; a wharf boat for Memphis; and two car-ferry barges of 14 cars capacity each, for gravel ballast cars of the Illinois Central R. R. at Profit Island. The company is now building for the government four barges for river maintenance work, at Greenville, and a floating drydock at Vicksburg, Miss.

A TELEPHONE RELAY, devised by Mr. S. G. Brown, M. Inst. E. E. (4 Great Winchester St., London, E. C.), is described in London "Electrician" of May 6. This instrument is intended to supply the need for a relay that would intensify faint telephonic speech. This relay depends fundamentally on the inverse variation of flow of electricity across a microscopic air gap with any minute change in the gap. The gap is between osinum-iridium contacts mounted, one on a steel reed and one on the end of a fine screw. The feeble telephone currents to be magnified pass through coils on the end of a permanent magnet whose armature is the contact-bearing reed. The small telephone currents give sufficient variation in the length of the microscopic gap between contacts to cause a similar variation in the current flowing across the gap. This varying current, moreover, is led through a coil also on the legs of the permanent magnet and adds to the effect of the telephone currents. The device has also been arranged as a direct microphone and as a powerful stethoscope.

THE BUTTING POWER OF MANY FISHES.—The following note is an extract from a recent article in the Minneapolis "Journal":

Fish have butted against the piles supporting the bridge at Orono, Lake Minnetonka, until they have weakened the bridge and made it unsafe, according to the report filed to-day with the County Surveyor by his two deputies, who yesterday went out, inspected the bridge and closed it forthwith.

The deputy inspectors report that in their wild rush through the narrow channel the bass, croppies, and pike are unable to dodge the piles, they come in such numbers. One fish, they admit, would not push a pile far out of position, but hundreds and thousands of fish, they say, keeping up the same thing day after day, and year after year, have rendered the bridge dangerous.

Before returning to the city, the inspectors placarded the bridge with signs warning teams and automobiles to keep off. The bridge will be closed officially until the piling is repaired.

With all due respect to the deputy inspectors we are inclined to suspect that these fish belong to the same field of natural history as did the famous birds that last year attested the strength of the Queensboro Bridge in New York City.

History of the Rock Drill.*

By W. L. SAUNDERS,† M. Am. Soc. M. E.

The percussion rock-drill, as distinguished from other types, is an American invention, the first practical patents having been taken out by J. J. Couch, of Philadelphia, in 1849. He was assisted in building this drill by Joseph W. Fowle, later of Boston, their experiments being carried on during the year 1848. The nearest approach to rock-drill inventions abroad was in the German work of Schumann, in 1854. The Couch drill was a crank-and-fly-wheel machine and its application to practical work was therefore limited to surface-hole drilling. In 1848 Couch and Fowle separated, Mr. Fowle filing a caveat in 1849. This caveat describes the type of successful power rock-drills used to-day. The principal feature was that the cutting tool was attached directly to the piston or to the cross-head connected with the piston; in other words, the bit leading into the hole was an extension of the piston rod.

This important invention was described by Mr. Fowle in his testimony before the Massachusetts legislative committee in the contest with Burleigh in 1874, as follows:

My first idea of ever driving a rock-drill by direct action came about in this way: I was sitting in my office one day after my business had failed and happening to take up an old steam cylinder, I unthinkingly put it in my mouth and blew the rod in and out, using it to drive in some tacks with which a few circulars were fastened to the wall.

Mr. Fowle being without means, but a genius in the true sense, his inventions remained in obscurity until Charles Burleigh purchased his patents and produced the Burleigh drill, about the year 1866. This drill was used in the Hoosac Tunnel in 1867. Following these inventors came Haupt, De Volson Wood, and Simon Ingersoll, followed by Sergeant, Waring, and Githens, the inventor of the Rand drill.

The Ingersoll drill was invented in 1871. Simon Ingersoll, an ingenious, modest and honest mechanic, came to New York from Connecticut. Having a very fertile mind, he had conceived several inventions, models for which he made with his own hands. He was of a very confiding and loquacious disposition and once, while riding on a horse-car in New York, described to a fellow-passenger the merits of one of his inventions. One of the passengers in the car who overheard the conversation was John D. Miner, a contractor, who had a gang of men at work upon rock-excavation in what was then the upper part of New York. Mr. Miner broke into the conversation by asking Mr. Ingersoll why he didn't invent a rock-drill, something practical, something useful, instead of spending his time and his genius upon "such traps." Ingersoll asked him what he meant by a rock-drill, and what he wanted it to do. Miner's reply was that he had a gang of men at work in New York striking steel with a hammer in order to make holes in rock for blasting, that they could only do about 10 ft. per day, and that he could not see why the work should not be done by machinery. Ingersoll said he could make a machine to drill the rock and would go at it at once if he had the money. Miner then and there gave him $50, together with his card, telling Ingersoll that, though he had never met him before, he knew an honest face when he saw it and would trust him to spend that $50 in building a rock-drill. "When you want any more," said Miner, "come to me and I'll give you another $50."

Mr. Ingersoll made his drawings and models and built his first rock-drill at a little shop on the corner of Second Ave. and 22d St., owned by J. E. de Navarro, who operated it under the management and title of Sergeant & Cullingworth. Henry C. Sergeant came into the works one day and saw the patterns for the drill. The front head was attached to, and was a part of, the cylinder. Mr. Sergeant's fertility in inventions was never more marked than when he promptly told the mechanics that the head and cylinder should be in two pieces; and of his own accord he took a hand-saw and was in the act of separating them when the inventor, Ingersoll, arrived. "What are you doing?" said Ingersoll. "I'm making this thing practical," was Sergeant's response as he finished sawing off the head before Ingersoll could stop him. The result was the first row between Ingersoll and Sergeant, which afterward resulted in Sergeant's inducing Mr. Navarro to purchase all Ingersoll's rights and patents; but the drill was made with the detached front head, as it is to-day.

The success of the machine was soon apparent, and after Mr. Navarro had purchased the patents he organized a company called the Ingersoll Rock Drill Co., putting $10,000 in the enterprise. Mr. Sergeant was now in full control and through him many very important improvements were made. Litigation arose at once with Mr. Burleigh of Massachusetts, who owned the Fowle and other rights; but through Mr. Navarro's plentiful command of funds and his liberal nature, the suits were settled and all fundamental patents placed with the Ingersoll company. The $10,000 which started the drill business was shortly afterward paid back to Mr. Navarro, and eventually he sold his rights for $525,000 to R. W. Chapin. Mr. Sergeant soon afterward sold out because of friction with the management, went west, engaged in mining, lost his money, returned to New York about the year 1885 and started the Sergeant Drill Co.

Addison C. and Jasper R. Rand had early become interested in rock-drills through their connection with the Laflin & Rand Powder Co. Addison C. Rand formed the Rand & Waring Drill & Compressor Co., later controlled entirely by Mr. Rand and merged into the Rand Drill Co., established in 1871 and incorporated in 1879. J. C. Githens, Superintendent of the Rand Drill Co., was the inventor of the "Little Giant" rock-drill and also the double-screw column with column arm, which made practical the application of the rock-drill for mining and tunneling. The Sergeant & Cullingworth Co. (building the Ingersoll drill), the Sergeant Drill Co. and the Ingersoll Rock Drill Co. were merged into the Ingersoll-Sergeant Drill Co., and later on the Rand Drill Co. was added to this amalgamation, forming the present Ingersoll-Rand Co.

*Reprinted from the "Mining and Scientific Press" of May 21, 1910.

†President, Ingersoll-Rand Co., New York City.

Electricity for Farm Work and Irrigation.*

By HERMAN RUSSELL.†

The Rochester Railway & Light Co. supplies Rochester, N. Y. (200,000), with electric light and power. The electric development of the company is both steam and hydraulic, supplemented by a purchase of Niagara power. It has generating apparatus for the production of 38,000 HP., and the necessary equipment to distribute this. From April 1 to Oct. 1 of every year 10,000 HP. lies idle (representing an investment of $2,500,000). This represents the amount necessary to take care of the heavy peak loads in November, December and January. During these months, from 10 p. m. to 6 a. m., there is 10,000 HP. waiting for a consumer.

The conditions, as outlined above, are true of every service company in the United States, and it is probably a conservative statement that during these months 40% of the plant capacity is producing no revenue, and that 75% is non-productive during six hours of every 24. The problem that confronts the companies is to find a market for this power during these months; in other words, a summer customer who stays off the peak both daily and seasonly.

In searching the field for a possible consumer of this character, the attention of the Rochester company was attracted to the growing use of power on the farms, and especially to the increased use of power for irrigation pumping in the West, and the very attractive load features that this business offers. The question at once arose, "Is there not a market for this power in rural sections, and should not irrigation be practiced by the farmers of the east as well as of the west? If so, can we not extend our lines into the country and sell the power now idle for irrigation pumping at special rates, and incidentally secure much additional farm business?"

The modern farmer wants electric power on his farm, and he is willing to pay for it. That this is the case is shown by the increased use of electricity in rural districts. Here and there all over this country (in New York, Illinois, California, Colorado, and in fact in almost every State) are to be found farms partially or completely equipped with electric power. The reasons for this wonderful growth of electric use on the farm are not hard to find nor difficult to understand. The improvement in country roads, the growth of the automobile, the extension of the telephone and rural delivery service, have brought the city and the country closer and closer together, with the result that a farmer and his family are no longer an isolated set of individuals, out of touch with the world and modern progress.

Electric lights mean comfort in the farmhouse and a lessening of the fire hazard. By providing suitably lighted buildings, work can be done more efficiently; that is, more work and fewer hours. Electric power with its factors of safety, reliability, cleanliness, flexibility and ease of application is peculiarly adapted to pumping water, driving conveyors, running churns, separators, feed cutters, milking machines and grinders; to operating hoists, spraying machines, saws and machine tools; even to doing the household washing and ironing, and providing a cold-storage plant. For these purposes, and many more, electric power is now used on the farms of the country. In Europe, where much greater progress has been made than in this country, ploughing, cultivating, etc., are being done with the aid of electricity.

At present most of the electric service on the farm is being supplied by the farmer himself, the gasoline, steam or suction-gas plant usually furnishing the motive power, with an occasional hydro-electric private development. A beautiful example of the latter is to be found on the farm of Mr. W. H. Miner, at Chazy, N. Y. Two streams have been dammed and hydro-electric equipment of 192-KW. capacity with storage battery has been installed; transmission lines are 1¼ and 2¾ miles long. There is also a small steam reserve unit operated in connection with the heating system. There are 25 motors aggregating 123½ HP. doing the farm work at the present time. Three years' operation has proved the efficiency and economy of the undertaking.

The use of gasoline engines for driving small generators, which in turn are used to charge storage batteries supplying electric light, is becoming very common. The advent of the tungsten lamp has aided materially in making this development possible. Manufacturers of farm machinery have taken up the subject, and the makers of electrical machinery are paying especial attention to the rural field.

Recently there has sprung up in many sections, especially in the Western states, a demand for power on the farms, which is so large and the nature of which is so attractive from a load standpoint, that it promises to justify for its satisfaction a very large expenditure on the part of service companies. I refer to the use of electric power for pumping water for irrigation purposes. All over the west water is being pumped electrically from wells, rivers, lakes and ditches for irrigation use. Large government and private company undertakings are now supplying water in this way for thousands of acres. Individual farmers, wherever electric power can be obtained, are installing pumping outfits and irrigating their own land, thereby saving the cost of water rights and maintenance charges, while obtaining water at a very reasonable cost when they want it and where they want it—a condition not always reached with gravity systems.

The electric development for irrigation pumping is proceeding in two ways: (1) A large pumping plant suitably located is installed, and all the water for a given acreage is pumped at this point to a higher level and then distributed by gravity—the power used being electric, with either steam or hydraulic generation; or (2) electric power is furnished from a central plant to the individual farmers, who supply their own water, either from streams, wells, gravity ditches or lakes, as the case may be.

The irrigating pumping load is especially attractive to a central-station, because it means a large power consumer who is strictly an off-peak customer. Power is used entirely during the summer months, and by special rates is in many cases used during hours of the day when there is almost no other load.

The considerations outlined above have caused the Rochester Railway & Light Co. to inaugurate a novel new business campaign. The writer has been delegated to give special attention to the subject of irrigation for the purpose of demonstrating to the farmers around about Rochester that it is to their interest to practice supplemental irrigation. A pumping plant has been installed on a fruit-farm near the city, and experiments are being conducted. Last summer a peach orchard was irrigated with such remarkable results that already a great deal of interest has been aroused, and a number of farmers along the shore of Lake Ontario are installing pumping plants to supply water for irrigating their farm this summer. At Irondequoit, a market-garden town adjacent to Rochester, the company is now supplying current at regular rates to more than 40 motors for farm use, most of which are for pumping water. The demand is increasing rapidly, and promises to reach large proportions this summer.

*Abstract of a paper read at the annual meeting of the National Electric Light Association at St. Louis, Mo., May 24-27.

†Rochester Railway & Light Co., Rochester, N. Y.

WATER METERS MUST BE INSTALLED at San Diego, Cal., on all new services within a year of the time the services are put in use. At the close of 1909 7,100 of 7,800 services were metered, or about 90%. The average water consumption was 86 gals. per capita in 1909, according to Venturi meter records. The foregoing statements are taken from a report of the Committee on Fire Prevention of the National Board of Fire Underwriters (135 William St., New York City).

DEPOSITS ON BOILER TUBES.—London "Electrician" of May 13 reports methods of overhauling the boilers of the Burton-upon-Trent Corporation, arranged by Mr. P. J. Pringle, M. Inst. E. E. The usual brushing down of soot, etc., from the fire surfaces of the boilers was found to remove any serious collection of soot and the softer materials, but a harder deposit was found to remain. Mr. Pringle taking a hint from the operation of economizers, decided to scrape down the transmission surfaces with hard steel scrapers, so as to get as near to the metal as possible. The deposit thus removed is found to be of a hard, ashy nature and of a thickness varying from 1/32-in. to 3/16-in. This scraping is done about once in two months. The result is stated to be a considerable increase in boiler efficiency. The total amount of fuel used by the Corporation has been reduced 14.8%, notwithstanding a slight increase in station output. A cheaper grade of fuel has been used also so that the expenditure for fuel has been decreased 27.0%.

Notes from Engineering Schools.

ARMOUR INSTITUTE OF TECHNOLOGY.—A gift of $70,000 from Mr. J. Ogden Armour has recently been announced. It is also reported that three scholarships in the departments of mechanical and electrical engineering have been established by Mr. Bernard E. Sunny, M. Am. Inst. E. E., of Chicago, Vice-President of the American Telephone & Telegraph Co.

UNIVERSITY OF WISCONSIN.—The Forest Products Laboratory of the University of Wisconsin, at Madison, Wis., was opened with appropriate exercises on June 4. An informal conference was arranged for representatives of various organizations and industries to discuss ways and means of making use of the laboratory. The program of the formal exercises provided for addresses by the following (among others): Governor Davidson, of Wisconsin; Dr. Charles Van Hise, President of the University; Mr. Henry S. Graves, Forester, U. S. Department of Agriculture; Mr. J. B. White, Chairman of Committee on Conservation, National Lumber Manufacturers' Association; and Mr. A. C. Hastings, President of the American Paper & Pulp Association.

THE BILL TO INCREASE THE CORPS OF ENGINEERS, U. S. A. (H. R. 7117), we are advised on good authority, will be reported favorably to the Senate in a few days by the Senate Committee on Military Affairs, as passed by the House without amendment. The bill was printed on p. 564 of our issue of May 12.

THE END OF THE OLD GRAND CENTRAL STATION in New York City began at midnight June 3, when the large waiting room and the last two terminal tracks were abandoned, and the entire business of the terminal transferred to the temporary terminal station on Lexington Ave., adjoining, which has for a year or two past carried the bulk of the traffic. The old station has stood for 39 years, and except for interior reconstruction it remained essentially as first built. The old arched wrought-iron train shed was taken down over a year ago.

RAILWAY ACCIDENTS IN PENNSYLVANIA during the month of April, 1910, according to the report of the State Railroad Commission, caused 101 deaths. Of those killed, 38 were trespassers, 30 employees, 6 passengers and 27 not classified. These figures include both steam and trolley lines. The steam roads killed 77 and injured 698, and the trolleys killed 24 and injured 353. Of the passengers killed, the steam roads were responsible for 3 and the trolleys for 3; employees, steam roads, 28; trolleys, 2; trespassers, steam roads, 35; trolleys, 3.

THE BOSTON & EASTERN RY., a proposed line from Lynn and other northern suburbs of Boston into the city involving a tunnel under Boston Harbor, seems to have approached a consummation of its plans. The Committee on Metropolitan Affairs of the Legislature has requested the Railroad and the Boston Transit Commissions to frame a bill giving this company the right to tunnel under Boston Harbor. The whole project was described in Engineering News, 1908, Jan.-June, pp. 196, 504 and 644. It will be remembered that the Railroad Commission declared that public necessity had been shown but that a certificate could not be issued in the absence of legislation permitting the company to build part of the proposed tunnel and subway. The legislative committee named asks the two commissions to fix the tunnel location and terminals so that the project shall not interfere with a possible tunnel between North and South stations.

A MINE CAR COUPLING FAILED June 3 at the Lamont mines on Cabin Creek, W. Va. The detached car ran back down a 1,500-ft. incline and was wrecked. Three men in the car were killed.

LIGHTNING STRUCK IN A REGIMENT of German Infantry marching into the camp at Dresden, Saxony, June 7. According to press reports, three soldiers were killed and 15 others suffered severe injuries.

A nitroglycerine factory at Schlebusch, six miles from Cologne, was struck by lightning on the same date. An explosion resulted which wounded about 20 men and wrecked a large part of the plant.

TWO EXPLOSIONS IN CEMENT ROCK QUARRIES, reported last week, killed a total of 33 men. An explosion in the quarry of the Union Portland Cement Works at Devil's Slide, Utah, June 1, killed 25 laborers. Reports state that about 30 kegs of blasting powder were stored close to where the men were working.

A premature explosion at the quarry of the Lehigh Portland Cement Co. at West Coplay, Pa., June 2, killed eight men of the blasting gang. The gang was engaged in loading a battery of 70-ft. holes. Two holes had been loaded and a third partially loaded when the explosion occurred. Four of the twelve men in the gang escaped with slight injuries.

AN EARTHQUAKE IN SOUTHERN ITALY shortly after 3 a. m., June 7, destroyed a large part of the town of Calitri and did lesser damage in a dozen other villages. About 40 lives were lost, half of these at Calitri. The shock was most severe in the province of Avellino, near the extreme southwest coast, and lasted about ten seconds.

A SEVERE SHORT CIRCUIT, on the third-rail system of the New York Subway at Brooklyn Bridge station, tied up traffic for an hour and three-quarters on June 5. Temporary repairs were made and power was restored only to have a second and worse short circuit develop. It was reported that 18 ins. of the third-rail had been melted. Sparks from the first short circuit started a fire in a small accumulation of paper and made a smudge that alarmed the stalled passengers.

This accident is but one of several troubles which have occurred on the subway recently, none of which, however, has been very serious. About midnight, June 1, there was a rear-end collision at the Mott Ave. station. It is reported that a smudge from greasy waste which had become ignited by a fault in the power circuit, filled the tube so that the motorman could not see the signals before him. There were no safety stops at these signals to prevent running past a prohibitory signal. About 12 persons were slightly injured in this accident.

AN AEROPLANE FLIGHT across the English Channel from Dover to Calais and return, without alighting, was made by Capt. Charles S. Rolls, of London, on June 2, with a Wright biplane. The 42 miles were covered in an hour and a half.

The successful flight of Glenn H. Curtiss from Albany to New York, noted last week, has stimulated American interest in long-distance cross-country flights. Prizes aggregating some $55,000 have been offered in the last few days for trips from New York to Philadelphia, to Chicago and to St. Louis.

ACCIDENTS HAPPENING ON FERRY-BOATS in New York Harbor do not come within the jurisdiction of the Public Service Commission, in accordance with an opinion of the Commission which was recently published. The Commission holds that these boats are under the jurisdiction of the Federal Government while passing from landing to landing, but that all accidents occurring at terminals or freight yards must be reported to the Commission.

THE FLOATING DRY DOCK "DEWEY" sank at her moorings in Olongapo, P. I., on May 24, and to date has not been raised. It is not known just what was the cause of the sinking, but it is thought that it was due to the faulty manipulation of some of the valves, probably through ignorance on the part of the attendants. At first it was reported that there was malicious intent on the part of these same employees, who are for the most part Japanese, but this report has not been confirmed. It is expected that it will take some weeks yet before the dock is raised and meanwhile the cause of the accident cannot be definitely stated. The commander of the yard has requested an allotment of $15,000 to raise the dry dock.

THE CAPE COD CANAL.—Work is in progress at both ends of the canal. The entire line consists of 8 mi. of canal section between tidewaters and about 5 mi. of dredged channel in Buzzards Bay. A ladder dredge and a dipper dredge are at work in the Buzzards Bay section opening up an 18-ft. channel to the mouth of the Monument River, which will later be deepened to 25 ft. Near Buzzards Bay station bridge, piers have been completed and a Strauss lift bridge of 100-ft. span is under construction to carry the relocated lines of the Old Colony R. R. across the canal. Work will shortly start on the necessary grading for the approaches to this bridge. No work has yet been started on the middle section of the canal, but at the Sandwich entrance on Cape Cod Bay two hydraulic dredges are at work taking out about 25,000 cu. yds. a day. In advance of their work two revolving scraper bucket excavators are taking off a dry section at the top of the slope on one side of the canal and forming a dike behind which the hydraulic dredges pump. The breakwater is under construction to protect the Cape Cod mouth of the canal from storms and littoral drift.

The finished canal, as proposed, will have a minimum bottom width of 100 ft. through the center cut, with three passing places 200 ft. in width, and dredged approach channels 250 ft. in width in Buzzards Bay and 300 ft. in width in Cape Cod Bay, with a minimum depth at low water of 25 ft. ("Monthly Bulletin," Boston Society of Civil Engineers, May, 1910.)

THE RICHMOND, VA., REINFORCED-CONCRETE conduit for conveying the city's water from the coagulating basins to the pump houses, which failed under test in the fall of 1908 (Engineering News, Oct. 20, 1908, p. 482) has been replaced by another reinforced-concrete conduit of different design. As reported at the time of its collapse the old conduit consisted of a three-centered high-crowned arch section built upon a curved invert, with a marked construction plane between the two sections. Under pressure of 9 lbs. per sq. in., or about 1 lb. less than the designed capacity, a number of cracks appeared along the construction plane mentioned to the extent that the whole conduit was condemned.

The new conduit is a circular pipe with 54-in. inside diameter and 7-in. thickness, reinforced in the middle of the shell with circumferential ⅝-in. corrugated bars spaced 6-ft. c. to c. and longitudinal 1-in. corrugated bars spaced 6 ins. c. to c. This pipe rests on the base of the old conduit which was left in place after the upper portion had been removed.

The removal of this upper portion was accomplished by separating the pipe in 400-ft. sections by bulkheads, filling these sections with water. Dynamite sticks were then let down under water into the center of the pipe through 1½-in. holes drilled along the middle line of the top of the pipe every 6 ft. All of the dynamite sticks in one section were connected to a battery and the charge fired. The process was remarkably successful, laying the sides and top of the conduit down at the side and leaving the base practically unharmed and ready for the new conduit.

The design was carried out under the direction of a board of engineers appointed by the city and the contract was executed by the Piedmont Construction Co., Atlanta, Ga.

THE HYPOCHLORITE PLANT for treating the water-supply of Jersey City has been reported on by Mr. William J. Magie, Special Master in Chancery, in accordance with the terms of reference made in a lawsuit between the city and the Jersey City Water Supply Co. The Master declares that hypochlorite treatment is efficient and reliable and enables the company to meet the terms of its contract with the city as to quality of the water furnished. It may be explained that some years ago a contract for constructing works to supply water to Jersey City was assigned by an individual contractor to the Jersey City Water Supply Co. Under the terms of the contract the company was to build a large storage reservoir on the Rockaway River at Boonton, N. J., and a conduit therefrom to connect with the existing waterworks of Jersey City. The contract contained one of the all-too-common indefinite provisions for "supplying pure and wholesome water" or something to that effect. When the city was ready to take over the works from the contractor, it claimed that the contract had not been fulfilled in all respects, and particularly not in the matter of preventing pollution of the water by the sewage of Dover, Boonton and Hibernia. The city claimed that the sewage and similar wastes of these relatively small towns polluted the water-supply and must be removed or purified, or possibly both. The court held on the evidence presented that, while for the most part no proof of pollution had been presented, yet at infrequent and short intervals through the year there were indications of sewage pollution which deserved attention. Further action regarding these phases of the suit was suspended until opportunity had been given the company to test the workings of the hypochlorite plant, described at length in our issue of June 24, 1909. Mr. Magie was instructed by the Court to report on the estimated cost of the sewage works urged by Jersey City, and also on the efficiency of the hypochlorite plant. His report was handed down on May 9, 1910. We are indebted to Dr. J. L. Leal, of Paterson, N. J., Sanitary Adviser of the Jersey City Water Supply Co., for a copy of Mr. Magie's report, which is dated May 9, 1910. The report deals in some detail with the estimated cost of intercepting and trunk sewers and sewage treatment works for Dover and Boonton, and also gives estimates for two different plans of dealing with the sewerage and other wastes at Hibernia. It is unnecessary to give details of the estimates here, although it may be stated that altogether, for the three communities, they run into several hundred thousand dollars first cost, and involve considerable annual expenditure for capital charges and operating expenses. As contrasted with this, Mr. Magie reports that the hypochlorite plant which has already been installed and paid for by the Jersey City Water Supply Co. was $20,546, and that the annual cost of operating and maintaining the plant would be $2,100. This plant, it appears, if finally accepted by the Court as filling the contract, will be included in the transfer of the property of the water company to the city. Mr. Magie declares that the hypochlorite plant

is capable of rendering the water delivered to Jersey City pure and wholesome, for the purposes for which it is intended, and is effective in removing from the water those dangerous germs which were deemed by the decree to possibly exist therein at certain times.

It will be understood that the findings of the Master in Chancery now go to the court for acceptance, modification or rejection, as the court sees fit.

RULES FOR THE SANITARY REGULATION of shell-fish, formulated by the Board of Food and Drug Inspection, U. S. Department of Agriculture, went into effect on May 1, 1910. In view of the fact that shell-fish, and

particularly oysters, have been associated in the past with typhoid outbreaks, we reprint in full a circular containing the ruling. The circular was issued on Oct. 15, 1909, but, as we have already stated, the ruling did not go into effect until May 1, 1910. The circular is signed by Messrs. H. W. Wiley, Chief Chemist of the Department named, and F. L. Dunlap and George P. McCabe. It reads as follows:

The Department has investigated the preparation and shipment of oysters, clams and other shell-fish. A public hearing on this subject was held by the Board of Food and Drug Inspection on May 20, 1909. At this hearing, growers, packers, dealers and the public were afforded an opportunity to be heard.

It is unlawful to ship or to sell in interstate commerce oysters or other shell-fish taken from insanitary or polluted beds. The pollution of oysters with sewage can readily be detected by bacteriological examination, and such polluted oysters or other shell-fish are adulterated under Section 7 of the Food and Drugs Act of June 30, 1906, in that they contain an added "poisonous or other added deleterious ingredient which may render such article injurious to health."

Such articles are likewise adulterated under Section 7, in the case of foods because they consist "in whole or in part of a filthy, decomposed, or putrid animal or vegetable substance."

It is unlawful to ship or to sell in interstate commerce oysters or other shell-fish which have become polluted because of packing under insanitary conditions or being placed in unclean receptacles. In order to prevent pollution during the packing or shipment of oysters, it is necessary to give proper attention to the sanitary condition of the establishment in which they are packed and to use only receptacles which have been thoroughly cleansed as soon as emptied. In order to prevent the possibility of contamination, it is desirable that such containers be sterilized before using.

It is unlawful to ship or to sell in interstate commerce oysters or other shell-fish which have been subjected to "floating" or "drinking" in brackish water, or water containing less salt than that in which they are grown. Such food is adulterated under Section 7 of the law because a substance "has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength." There can be no objection to "drinking" shell-fish in unpolluted water of the same salt content as that from which they have been removed. Attention is called, however, to the dangers resulting from "drinking" shell-fish near polluted fresh-water streams and near other sources of pollution.

It is unlawful to ship or to sell in interstate commerce shucked oysters to which water has been added, either directly or in the form of melted ice. Such food is adulterated under Section 7 of the act because a "substance has been mixed and packed with it so as to reduce or lower or injuriously affect its quality or strength," and also because a "substance has been substituted wholly or in part for the article."

The packing of shell-fish with ice in contact may lead to the absorption by the oyster of a portion of the water formed by the melting ice, thus leading to the adulteration of the oysters with water.

Only unpolluted cold or iced water should be employed in washing shucked shell-fish, and the washing, including chilling, should not continue longer than the minimum time necessary for cleaning and chilling.

In view of the fact that the shipping season has begun and shippers will require several months to provide themselves with suitable containers for the shipment of shell-fish out of contact with ice, no prosecutions will be recommended prior to May 1, 1910, for the shipment or sale in interstate commerce of oysters or other shell-fish because of the addition of water caused solely by shipment in contact with ice.

MUNICIPAL OWNERSHIP OF WATER-WORKS at Oakland, Cal., has received at least a temporary setback through the withdrawal of the option given the city by the People's Water Co. to purchase the property of the latter for $16,600,000. The cause for cancelling the option is said to have been failure of the city and company to agree about the termination of the litigation over water rates, which has been going on for a half-dozen years or more.

THE LIFE OF THE NEW YORK AQUEDUCT COMmission came to an end on June 1. The Commission was established 27 years ago to introduce an additional water-supply from the Croton River by means of a second aqueduct. The work also involved the building of the New Croton Dam and other dams and reservoirs in the Croton drainage area. It was strongly felt in many quarters that the Commission was unduly prolonging its life by attempting to build reservoirs beyond the economic storage capacity of the drainage area. To bring the life of the Commission to an end, Mayor Gaynor, soon after taking office, adopted the simple expedient of removing all the members of the Commission and appointing a new set of men, with the distinct understanding that they were to wind up the affairs of the Commission. The old commissioners appealed to the courts, but the courts decided against the commissioners. To make assurance doubly sure, state legislation was sought to bring the life of the Commission to an end. This was secured, so there now seems to be no doubt that the Commission is really extinct. The works under its jurisdiction not already transferred to the Department of Water Supply, Gas and Electricity have now been so transferred, together with the records of the Commission.

MEMBERSHIP IN THE CITY COUNCIL of Indianapolis, Ind., was recently reduced to nine. Prior to last winter, the membership was 21, of which 15 were elected one from each ward and six at large. With the reduction in membership, the city was divided into six election districts. Each political party nominates one member from each election district, or a total of six. As a result, minority representation for one or more parties is ensured, and at the same time it is always likely that any given election will result in the choice of a considerable number of candidates at large instead of by wards. Coincident with this change, the Mayor is given full executive responsibility. He fills all appointive offices without confirmation by the City Council. This means that he appoints practically all the executive officers of the city, since, besides the Council and the Mayor, the only elective officers are clerk and police judge. The executive boards are those dealing with public safety, health and parks. The city engineer, comptroller and corporation counsel are appointed by the Mayor. It is interesting to note that the powers of the Board of Public Works are so regulated that the Board can initiate and carry through proceedings for improvements within two months, notwithstanding the protests of property owners. Any protests made in case damages are involved are considered by the court, and adjudication is made without regard to the progress of the proceedings.

A PENSION SYSTEM for employees of the Western Electric Co., of Chicago and New York, is described in the "Electrical Review and Western Electrician" of May 28. It appears that in 1906 the company set aside $400,000 out of profits and later made additions which have swelled the fund to $597,500. The fund is managed by a board of five employees appointed by the board of directors or the executive committee of the company. All employees, 60 years of age who have been in the company's service for 20 consecutive years, are eligible to the pension benefits whether able to work or not. Employees, 55 years old and having been 25 years in the company's service, or of any age if having been 30 years with the company, are entitled also to pension benefits. Men receiving pensions are not debarred from going into other business. An employee who has been ten years in service and is incapacitated by injury or sickness may be given help from this fund at the discretion of the administering board.

Pension allowances for age and length of service are fixed as follows: For each year of continuous service, 1% of annual pay (average of ten years next preceding retirement) is allowed. The pension board may base allowances on an average of the ten consecutive years during which the highest wages were paid. Allowances are paid monthly from retirement to death and may be continued one year for widows or orphans. The expenses of the system are not borne by employees in any way.

A NOVEL TEST, an application of the idea of endurance testing, was carried out recently by the National Tube Co. They wished to demonstrate the endurance qualities of an iron-on-brass pipe union ("Kewanee" union), and two such unions, 1½-in. and 1-in., were subjected to the test. The test union was connected in a steam line, with a valve on either side, one of the latter opening to the atmosphere. The union was tightened up with a hand wrench, steam admitted, the outer valve opened to the air and again closed, and the union inspected for leakage. The pressure was now shut off, and the union disconnected completely. Then the union was again connected and the whole operation gone through; and in this way 1,000 repetitions were given to each of the test unions. At no time during either test was any leakage discovered, and after the test, by trying the unions under water with 110 lbs. internal air pressure, they were found absolutely tight. The obvious comparison with a gasketed union, in which the gasket would require frequent renewal in such a repetitive test, was of course strongly in the minds of the manufacturers. The idea represented by the test, however, is the broader use of subjecting a working part to an accelerated repetitive trial to prove its adequacy in all points.

STORM OBSERVATORY.—It is announced in the London "Electrician" of May 6 that

a thunderstorm observatory has been established in Spain by Señor G. J. de Guillen Garcia, in which atmospheric discharges, both local and distant, are detected graphically and acoustically. A wireless-telegraph instrument is used for this purpose, because each lightning discharge is accompanied by ether waves similar to those used in wireless telegraphy. If there is a storm anywhere within a radius of 500 miles the observer is notified of the fact by the recording instrument. As all barometric depressions that pass over Western Europe are claimed to come from the Atlantic Ocean, the new observatory gives meteorologists due warning of the approaching disturbance. By noting the intensity of the sounds produced in the receiver and observing whether they grow more distinct or less, it is possible to determine the approximate course of a storm.

PINTSCH INCANDESCENT GAS LAMPS.—The extent to which inverted-mantle gas lamps have proved serviceable for railway cars is indicated by figures collected by the Safety Car Heating & Lighting Co., New York City, manufacturers of the American Pintsch apparatus. Over 73,000 lamps, using the inverted mantle, have been placed on cars since Oct. 1, 1909, bringing the lamps in service up to a total of 432,000. Of this 60,000 are in North America, 69,000 in England, 101,000 in France and 202,000 in Germany.

With the development of the inverted-mantle lamp for railway service, a 40% reduction has been made in the gas consumption per car with a 300% increase of light.

An important fact of this development is the rapid rate at which the old lamp equipment is being brought up to date for use with the inverted mantle. About 60% of the railroads of North America have already applied the single mantle lamp; some have changed their entire equipment and others have contracted to do so. On many roads the work is being carried forward as rapidly as it is possible to release the cars from service. Over 22,000 flat-flame lamps have recently been changed so that the new lamps are now in service on more than 8,200 cars in the United States, Canada and Mexico.

Personals.

Mr. W. D. Hodge, formerly with the Chicago & Northwestern Ry., has been made Chief Engineer of the Denver, Laramie & Northwestern R. R., at Denver, Colo.

Mr. J. B. Balcomb, Consulting Engineer, has concluded his work in connection with the sewer system of Kansas City, Mo., and will open an office in the Title and Trust Bldg., Chicago, Ill.

Mr. Geo. E. Dunan, formerly with the Morey-Faulhaber Construction Co., of St. Louis, Mo., has been made Engineer of Roadway and Structures, Apalachicola Northern R. R., with headquarters at Apalachicola, Fla.

Mr. John Duder, Assoc. M. Am. Soc. C. E., Assistant City Engineer of Salt Lake City, Utah, for the past four years, has resigned to become Chief Engineer in charge of the practice of the Birch Co., Engineers, of the same city.

Mr. W. J. Douglas, M. Am. Soc. C. E., has resigned from the position of Engineer of Bridges, District of Columbia, and associated himself with Mr. Wm. Barclay Parsons, consulting engineer, 60 Wall St., New York City.

Mr. Mansfield Merriman, M. Am. Soc. C. E., of New York City, formerly Professor of Civil Engineering at Lehigh University, was married June 6 to Miss Bezena T. Downes, daughter of the late Alonzo M. Downes, of New York City.

Mr. W. P. Snow, M. Am. Soc. C. E., for the past twenty years with Lockwood, Breene & Co., Mill Engineers, of Boston, Mass., has been appointed Resident Engineer on the hydro-electric development for the Palmer Mills, Three Rivers, Mass.

Mr. N. A. Carle, M. Am. Soc. M. E., Assoc. M. Am. Inst. E. E., formerly Engineer with Westinghouse, Church, Kerr & Co., New York City, has opened an office in Seattle, Wash., as a consulting engineer in mechanical, electrical and mining engineering.

Mr. C. D. Purden, M. Am. Soc. C. E., has been appointed Chief Engineer of the St. Louis Southwestern Ry., with headquarters at St. Louis, Mo. Mr. W. T. Eaton has been appointed Chief Engineer of the St. Louis Southwestern Ry. of Texas, with offices at Tyler, Tex. Mr. M. L. Lynch, M. Am. Soc. C. E., Chief Engineer of the entire St. Louis & Southwestern Ry. system, has resigned his position and the official announcement issued by the company states that he has retired "after many years of faithful service."

Mr. Charles Whiting Baker, Editor of Engineering News, sails for Antwerp on June 11 and will attend the International Congress of Mining, Metallurgy and Applied Mechanics at Duesseldorf, to which he has been appointed a delegate from the United States by the State Department. During the first two weeks of July Mr. Baker will attend the International Railway Congress at Berne, Switzerland, and will then go to England for the Joint Meeting of the Institution of Mechanical Engineers and the American Society of Mechanical Engineers, to be held in Birmingham and London during the last week of July. The main party of American engineers going over to attend this meeting will sail from New York on the "Celtic," July 16. During the first week of August, Mr. Baker will attend the International Road Congress at Brussels, and will sail from Antwerp on the return voyage Aug. 13.

Obituary.

Hugh Toler Booraem, a New York architect, died June 4 at Saranac Lake, N. Y. He was a member of the firm of Roos & Booraem, of New York City, who were until 1905 the architects for the Mutual Life Insurance Co.

William P. Bettendorf, M. Am. Soc. M. E., died on June 3 at Davenport, Iowa, from ptomaine poisoning after an illness of a few days. He was President of the Bettendorf Axle Co., of Davenport, builders of steel cars.

Charles E. Doyle, Vice-President of the Chesapeake & Ohio Ry., in charge of operation, died from apoplexy in his private car while on his way to Richmond, Va., on June 5. He was a native of Missouri, where he was born on May 29, 1851. He entered upon railway work early in life and had worked his way up from the ranks. In 1888 he was Superintendent of the Cairo, Vincennes & Chicago Ry., in 1889 Superintendent of the Pittsburg & Western. Since 1890 he had been with the Chesapeake & Ohio Ry.

William R. Tiffen, Superintendent of the Northern Division of the Grand Trunk Ry., died on May 30 at his home in Barrie, Ont. Mr. Tiffen was in his 65th year, and but a few days previously had celebrated his 50th year with the Grand Trunk Ry., having entered the railway service at the age of 15 as a junior clerk in the office of the superintendent of the old Great Western at Hamilton. He leaves three sons and a brother, Mr. E. Tiffen, General Traffic Manager of the Intercolonial Ry. and a member of the Government Rys. Managing Board.

Philip Cardew, of Godalming, Surrey, England, died on May 17 after an operation for tumor behind the nose. He was born Sept. 24, 1851, and graduated from the Royal Military Academy, Woolwich, in 1871, being the most distinguished cadet of that year. He was placed in charge of military telegraphs in Bermuda in 1876 and in 1877 joined the British Submarine Mining Service. He eventually became Major of the Royal Engineers. Major Cardew was electrical advisor to the London Board of Trade from 1888 to 1899, during the development of electricity-supply systems and the formulation of necessary local regulations. In 1899 he became a partner with Sir Wm. Preece and acted as consulting engineer for many undertakings. Major Cardew invented much electrical apparatus and devised many improvements in military telegraphy and electricity-supply systems.

Fred. C. Grant, a civil engineer employed until recently by the Standard Steel Car Co., died June 4 in the Butler Co. General Hospital at Butler, Pa. His death resulted from an attack of pneumonia contracted March 29 while at work on the construction of the open-hearth plant of the Forged Steel Wheel Co., of Butler, Pa. Mr. Grant was born in Troy, N. Y., in 1875, and was a graduate of Rensselaer Polytechnic Institute. He had been connected with the steel car business since its inception, first at the Allegheny plant of the Pressed Steel Car Co. and afterward with the same company at McKees Rock during the building of the plant at that place. In 1902 he went to the Standard Steel Car Co., of Pittsburg, Pa., to take charge of construction work and remained in the service of that company until the fall of 1909, when he was engaged by the Forged Steel Wheel Co.

Joseph S. Harris, former President of the Philadelphia & Reading R. R., died from apoplexy at his home in Germantown, Pa., on June 2. Mr. Harris was born in Chester County, Pa., on April 29, 1836, and graduated from the Central High School, Philadelphia, in 1853. He entered the railway service in April of the same year as rodman and topographer on the North Pennsylvania R. R. From 1854-1864 he was an officer of the U. S. Coast Survey, serving during the Civil War with Admiral Farragut's Mississippi River Squadron as first officer and later as commander of the U. S. S. "Sachem." While in the Coast Survey he was also engaged in the determination of a parallel of latitude in Kentucky and on the Northwest International Boundary Survey. From 1864-68 he carried on a private practice in civil and mining engineering at Pottsville, Pa., during which time he was also Engineer of the Lehigh & Mahanoy R. R. From 1868 on he became successively Chief Engineer of the Morris & Essex R. R., Engineer of the Philadelphia & Reading Coal and Iron Co., Superintendent and Engineer of the Lehigh Coal & Navigation Co., General Manager of the Central R. R. of New Jersey, President of the Lehigh Coal & Navigation Co., Receiver and later Vice-President of the Central R. R. of New Jersey, Vice-President of the Philadelphia & Reading Coal and Iron Co., Receiver and afterwards President of the reorganized Philadelphia & Reading Ry. and of the Philadelphia & Reading Coal and Iron Co. In 1901 he retired as active head of these companies but remained a director and in an advisory capacity on the matter of the company's coal properties. He was a trustee of the University of Pennsylvania, a member of the American Philosophical Society and the Historical Society of Pennsylvania. Mr. Harris is survived by a widow and three daughters.

Brig.-Gen. Cyrus Ballou Comstock, Corps of Engineers, U. S. A., retired, died at his home in New York City, May 29. General Comstock was born at West Wrentham, Mass., on Feb. 3, 1831, and was graduated from West Point Military Academy at the head of his class in 1855. He was commissioned Second Lieutenant of Engineers in September of the same year. He served throughout the Civil War; entering with the rank of First Lieutenant, he became assistant to the Chief of Engineers and took part in the Peninsular campaign of 1862. In 1862-63 he was Chief of Engineers of the Army of the Potomac and was engaged in the operations before Fredericksburg and Chancellorsville. He was senior engineer at the surrender of Vicksburg, Chief Engineer at the assault on Fort Fisher and senior aide-de-camp on the staff of General U. S. Grant when the latter was Commander-in-Chief of the Armies of the United States. In 1865 he was made Major of Engineers and served as aide to the commander-in-chief at Washington until 1870, after which time he became prominently identified with the Mississippi River improvement and the surveys of the Great Lakes.

In 1881 he became Lieutenant-Colonel of Engineers with the brevet rank of Major-General of Volunteers; was President of the Mississippi River Commission and a member of the Board of Engineers on Fortifications and River and Harbor Improvements. He was for many years a member of the American Society of Civil Engineers, resigning from that body in February, 1908. He was also a member of the National Academy of Science, the Loyal Legion and the Union and Century Clubs. He was the author of "Primary Triangulation of the U. S. Lake Survey" and of papers in the Transactions of the American Society of Civil Engineers.

He was retired from active service in 1895 and was promoted to the rank of brigadier general in 1901.

Engineering Societies.

COMING MEETINGS.

MASTER CAR BUILDERS' ASSOCIATION.
June 15-17. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 20-22. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 21-24. Annual convention at Chicago, Ill. Secy., Chas. W. Hunt, 220 West 57th St., New York City.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 22-24. Semi-annual meeting at Niagara Falls, N. Y. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 23-25. Annual meeting at Madison, Wis. Secy., Henry H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 27-30. Annual convention at Jefferson, N. H. Secy., R. W. Pope, 33 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 28-July 2. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
June 30-July 1. Semi-annual meeting at St. Louis, Mo. Secy., W. M. Mackay, P. O. Box 1818, New York City.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 26-28. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 16-19. Annual convention at Niagara Falls, Canada. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

AMERICAN STREET AND INTERURBAN RAILWAY ASSOCIATION.—The annual convention will be held at Atlantic City, N. J., Oct. 10-14, 1910. The secretary is Mr. H. C. Donecker, 29 West 39th St., New York City.

INSTITUTION OF ELECTRICAL ENGINEERS.—Partial occupation of the new home of this society was begun June 1. The institution recently acquired the Examination Hall of the Royal College of Physicians and Surgeons, on the Victoria embankment. The hall has been extensively reconstructed to adapt it to the use of the institution.

AMERICAN ASSOCIATION OF REFRIGERATION.—At the first annual meeting in New York City, May 9-10, officers for the ensuing year were elected as follows: Honorary President, Frank D. La Lanne, Philadelphia; President, T. O. Vilter, Milwaukee, Wis.; Vice-Presidents, W. D. Hoard, E. O. McCormick, Chas. Rohe, Jacob Ruppert, Jr., Thomas Shipley, W. J. Rushton, John E. Starr; Secretary, J. F. Nickerson, Chicago; Treasurer, J. S. Field, Chicago.

INSTITUTION OF CIVIL ENGINEERS.—The site of the present home of the institution, at 25 Great George St., Westminster, is now required for the extension of the offices of the British Government. New premises have been obtained with frontages on Great George St. and Princes St., and occupying an area of 21,000 sq. ft., considerably larger than the older site. The Building which is soon to be erected on the new site has been designed by Mr. James Miller. The institution has occupied premises at 25 Great George St. since 1838, but the present building was erected in 1896.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Papers to be presented at the 13th annual meeting at Atlantic City, N. J., June 28-July 2 are as follows:

June 28.—Committee Reports. Standard Specifications for Cast Iron and Finished Castings, Walter Wood Chairman; Standard Methods of Testing, Gaetano Lanza Chairman; Standard Specifications for Hard-Drawn Copper Wire, J. A. Capp, Chairman. "Tests of Cast-Iro Arbitration Test Bars," C. D. Mathews; "Some Recen Tests of Cast Iron," A. E. Outerbridge, Jr.; "Notes o the Annealing of Steel Castings," Albert Sauveur; "Untruly and Unevenly Chilled Car Wheels," T. D. West "The Forest Products Laboratory, Its Purpose an Work," McGarvey Cline; "The Closing of Blowholes i Steel Ingots," Henry M. Howe; "Measured Strains i a Steam Boiler under Hydrostatic Tests," James E Howard; "Copper Clad Steel, Its Metallurgy and Properties," Wirt Tassin; "Tests on Steel and Wrought-Iron Beams," H. F. Moore; "Strength of Steel from I-Beams," E. L. Hancock.

June 29.—Committee Reports on Standard Specifications for Steel, William R. Webster, Chairman; Standard Specifications for Cold-Drawn Steel, C. E. Skinner, Chairman. "Low-Carbon Streaks in Open-Hearth Rails," M. H. Wickhorst; "Elongation and Ductility Tests in Rail Sections Under the Manufacturers' Standard Drop-Testing Machine," P. H. Dudley; "The Influence of Titanium on Segregation in Bessemer-Rail Steel," G. B. Waterhouse; "Cupro-Nickel Steel," G. H. Clamer; "Test of a Structural Steel Plate Partly Fused by Short-Circuited Electric Current," A. W. Carpenter; "Further Notes on the Heat Treatment of Steel," William Campbell.

June 30.—Committee Reports on Standard Specifications for Cement, George F. Swain, Chairman; Preservative Coatings for Structural Materials, S. S. Voorhees, Chairman; Corrosion of Iron and Steel, A. S. Cushman, Chairman; Standard Tests for Lubricants, A. H. Gill, Chairman; Standard Methods of Analysis of Fats and Oils, C. N. Forrest, Chairman. "Aluminates; Their Properties and Possibilities in Cement Manufacture," Henry S. Spackman; "The Effect of Sodium Silicate Mixed with or Applied to Concrete," Albert Moyer; "Comparative Tests of Lime Mortar, both in Tension and Compression; Hydrated Lime and Sand, Lump Lime and Sand, and Cement Lime and Sand," E. W. Lazell; "Tests on Reinforced-Concrete Columns Subjected to Repeated and Eccentric Loads," M. O. Withey; "The Distribution of Stress in Reinforced-Concrete Beams, including a Comparative Study of Plain Concrete in Tension and Compression," A. T. Goldbeck; "A Sand Specification and Its Specific Application," W. A. Aiken; "A Method for Testing the Protective Power of Paints when Applied to Iron and Steel," W. H. Walker and M. T. Jones, Jr.; "Another Solubility Test on Protective Coatings," G. W. Thompson; "Vermilion Paint for Railway Signals; Results of an Investigation," Robert Job; "The Painting of Cement and Concrete Structures," Charles MacNicho; "Classification of Fine Particles According to Size," G. W. Thompson.

July 1.—Committee Reports on Waterproofing Materials, W. A. Aiken, Chairman; Standard Tests of Insulating Materials, C. E. Skinner, Chairman; Standard Specifications for Coal, J. A. Holmes, Chairman. "The 600,000-lb. Testing Machine of the University of Wisconsin," H. F. Moore and M. O. Withey; "The Scleroscope," A. F. Shore, followed by a general discussion on "Tests of Metals for Hardness," to be opened by Mr. A. F. Shore, Mr. Bradley Stoughton and Mr. A. S. Sauveur; "Some Testing-Laboratory Accessories," J. Madison Porter; "Brinell Ball-Test Applied to Wood," W. K. Hatt; "Apparatus for Repeated Loads on Concrete Cylinders and a Typical Result," H. C. Berry; "An Autographic Rubber-Testing Machine," T. Y. Olsen; "The Work of the Structural Materials Testing Laboratories During the Past Year," R. L. Humphrey; "The Determination of Soluble Bitumen," Prevost Hubbard and C. S. Reeve; "Improved Instruments for the Physical Testing of Bituminous Materials," Herbert Abraham; "Necessary Reforms in Specifications for Petroleum Products," Albert Sommer; "A New Machine for Testing Pitch," T. Y. Olsen; "Fuel Investigations, U. S. Geological Survey; Progress During the Year Ending June 30, 1910," J. A. Holmes.

July 2.—Committee Reports on Standard Specifications for Paving and Building Brick, L. W. Page, Chairman; Standard Tests for Road Materials, L. W. Page, Chairman; Standard Specifications for Vitrified Clay and Cement Sewer Pipe, Rudolph Hering, Chairman; Standard Specifications for the Grading of Structural Timber, H. von Schrenk, Chairman; Magnetic Testing of Iron and Steel, J. W. Esterline, Chairman. "A Comparison of Magnetic Permeaters," Charles W. Burrows; "The Exponential Law of Endurance Tests," O. H. Basquin.

Nominations of officers for the ensuing term (1910-12) have been announced by the executive committee as follows: President, Henry M. Howe; Vice-President, R. W. Lesley; Secretary-Treasurer, Edgar Marburg; member of the executive committee, James Christie. In addition to the amendments to the by-laws relating to classes of membership and dues, noted in our issue of May 5, the executive committee will propose an amendment changing the membership of that committee from seven to eleven members. This proposed change is due to the increased membership of the society.